AUTOMATION

JULY 1957

Random Access

IMPROVES INFORMATION HANDLING

The Magazine of Automatic Operations

- Applying Parts Selectors
- Integrated Machining Line
- Ultrasonic Cleaning Installation
- Tube Knurling

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A PENTON PUBLICATION

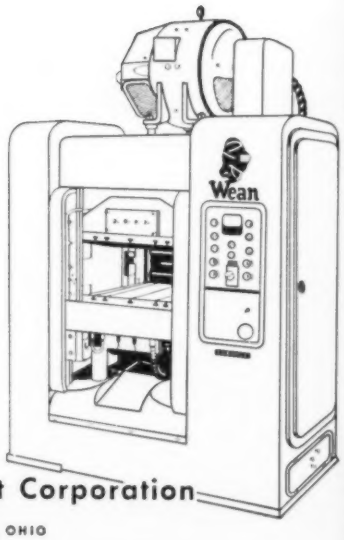
Production up almost 300% on compound pierce-and-blank operation

Production Rate: **Conventional press — 90 pieces a minute**
Wean "Flying Press" — 335 pieces a minute

The piece illustrated above is a circuit breaker cradle stamped out of .064 gauge strip steel. Length of index was 1¼". Involving a compound pierce-and-blank operation, it was produced on a conventional press at the rate of 90 parts per minute at the Westinghouse plant in Beaver, Pennsylvania. Using the same dies in a 60-20-36 "Flying Press", Westinghouse increased production to 335 parts per minute.

Speed, however, is only one phase of the "Flying Press" story. Automatic operation, centrally located controls, greatly reduced maintenance — all combine to make this the most remarkable press development since the turn of the century.

The whole story is covered in detail in the Wean "Flying Press" Brochure. Write for it today.



Wean Equipment Corporation
CLEVELAND 17, OHIO

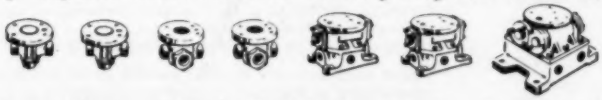
BLANKING | PROGRESSIVE BLANKING | COMPOUND PIERCE-and-BLANK | PROGRESSIVE DRAWING | PROGRESSIVE FORMING

Circle 651 on Inquiry Card

Ross Skyline

Silvermodel JIC Spool Solenoid

Any Skyline Head Attaches to Any Skyline Valve Body



Interchangeable! 25 Million Cycles in Tests!

Now the JIC spool solenoid valves join the Ross Skyline. Now six actuating heads and seven in-line and base mounted bodies—all completely interchangeable—give you any valve you want in this series designed especially to last millions more cycles than ordinary valves. But, these quality valves come to you at *sensible* prices! For instance, the 3/8" Silvermodel base mounted, 4-way is only $62.50 complete, and complies with all JIC requirements. Write for bulletin 315.

Ross OPERATING VALVE COMPANY

131 EAST GOLDEN GATE AVENUE • DETROIT 3, MICHIGAN

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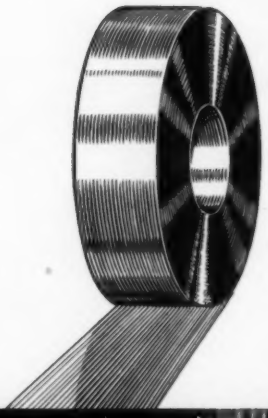
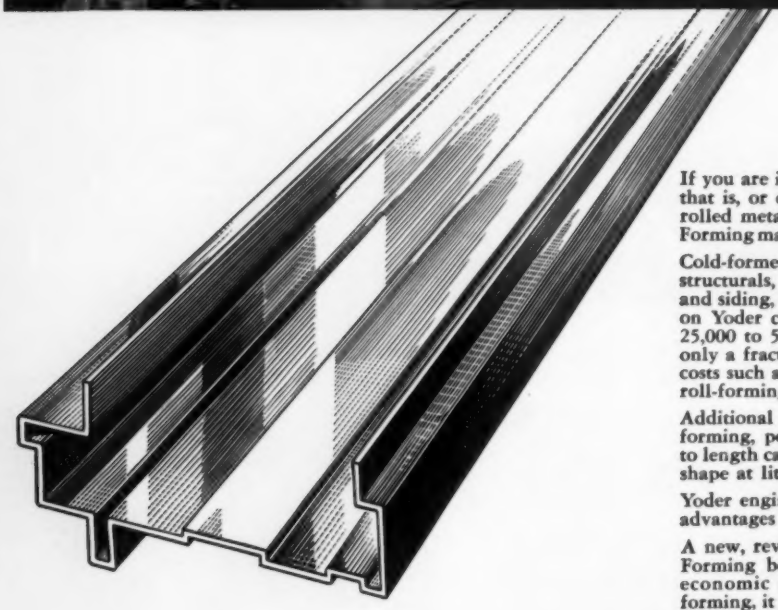
From Cold Strip to Finished Shapes
IN SECONDS
with a YODER
ROLL-FORMING MACHINE





If you are in the business of manufacturing a product that is, or could be, made wholly or partly from flat rolled metals in thicknesses up to ½", a Yoder Roll-Forming machine can help reduce your production costs.

Cold-formed shapes of every description—including structurals, tubular products, moldings, trim, roofing and siding, panels, cabinet shells, etc., can be produced on Yoder cold-roll forming equipment at the rate of 25,000 to 50,000 feet per day at a conversion cost of only a fraction of a penny per foot! With speeds and costs such as this, even part-time operation of a Yoder roll-forming line is a profitable investment!

Additional operations such as welding, coiling, ring forming, perforating, notching, embossing or cutting to length can be simultaneously introduced to the basic shape at little or no additional labor cost.

Yoder engineers are at your service in explaining the advantages of roll-forming for your individual needs.

A new, revised, Fifth Edition of the Yoder Cold-Roll Forming book is just off the press. In addition to economic and mechanical possibilities of cold-roll forming, it contains numerous illustrations of end uses and applications of roll-formed shapes. Write for your copy today.

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ENGINEERING
YODER
MANUFACTURING

COLD ROLL FORMING MACHINES
PIPE AND TUBE MILLS (ferrous or non-ferrous)
ROTARY SLITTING LINES

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JULY 1957
Vol. 4—No. 7

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

SAFETY AND HEALTH

". . . from the point of view of workers' health, the most obvious advantages of automation are the reduction of exposure to dangerous, toxic or irritant substances, radiations, dust, heat and other harmful agents and the general improvement of health conditions which result from the careful planning of factories and processes and from the need to provide climatic conditions in which highly complicated machinery can function continuously and perfectly. Physical fatigue and the danger of strains and hernias are materially lessened. The control of machines from a distance also has certain obvious advantages from the point of view of both safety and health . . ."—*David A. Morse, director general, International Labor Office.*

QUALITY CONTROL SOUGHT

". . . my firm is engaged in building automation systems. By far the greatest call we get for the design of such systems is for quality control purposes and not for labor saving as we thought it would be when we first entered the business. Almost always labor savings are achieved as well as material and power savings. But primarily the interest is always started from a quality control viewpoint. In general, such systems will always give better quality control at higher production rates. In many cases involving extremely high production rates, quality control can only be achieved by the use of correction devices working at the same rate if the inspection procedure must involve every piece. Usually the techniques of statistical sampling can be built into the control device. Time averages are almost invariably employed . . ."—*Alfred C. Block, general manager, Dynamics Research Associates.*

BUDGETED AUTOMATION

". . . if automatic parts handling equipment is to be of value to the average 'Widget' manufacturer, it must be within reach of his annual appropriation for 'cost reduction and methods improvement' projects. To automate the manufacture of the entire product would require such a substantial initial investment as to discourage all but the wealthiest of middle sized businesses. But considered subassembly by subassembly, it is possible to effect, in progressive stages, an automation program that on a yearly basis is within reach of most manufacturers, and which over a five-year period will produce a notable improvement in productive efficiency . . ."—*W. E. Horenburger, KDI Corp., see page 51.*

STANDARD COMPONENTS

". . . several companies have made real progress in standardized automation. This does not mean that inventories of assembly machines are maintained, ready for instant delivery upon order. But methods have been developed which speed delivery and make the final assembly machine available at a price lower than it would be if all parts were manufactured only when ordered. To cite our company practice as an example, indexing mechanisms, machined dials, housings, stands, control panels, etc. are produced in quantities. Upon receipt of an order for a transfer machine meeting the specifications of the stock items, various components are assembled. Special tooling is developed only if standard components cannot be used . . ."—*E. Gordon Reader, vice president and general manager, Ferguson Machine Corp., see page 59.*

AUTOMATION

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Published by

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R. C. JAENKE .....Executive Vice President
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Subscriptions in United States, possessions, and Canada for home-addressed copies and those not qualified under above rules: One year $10. Single copies $1.00. Other countries: One year $20.

Published monthly and copyrighted 1957 by Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation Publication at Cleveland, Ohio.

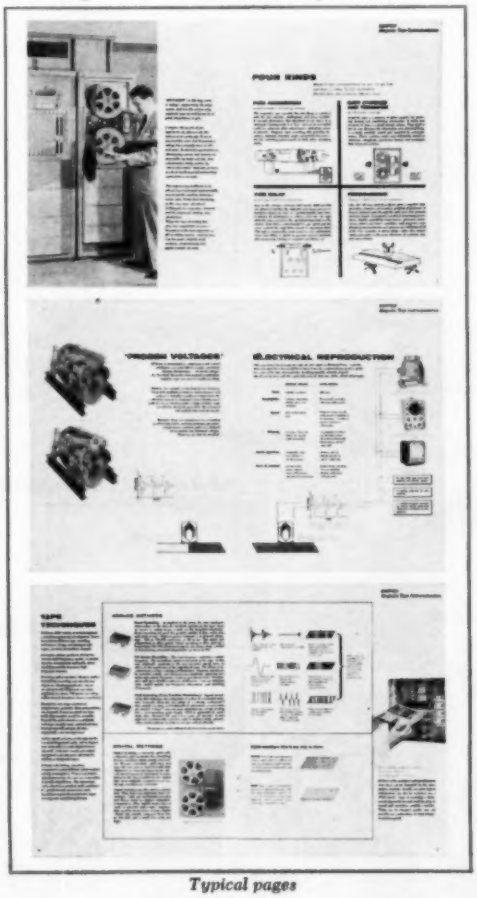
When requesting changes of address, etc., please allow four to six weeks for processing.

BPA NBP

How to be a magnetic tape recording expert

Introducing a useful new brochure on tape in instrumentation

Tape is the stuff of which memories are made — the versatile data memories for a jet propelled age of electronic miracles. If you are one who keeps up with times and techniques, it is a field well worth knowing. This new brochure gives a wide-angle view of the whole subject.



Typical pages

What kinds of applications do you think of when magnetic tape recording is mentioned? Sound recording, of course, and telemetering, if you are in that business. But what about simulating a rough road to test truck axles, controlling a milling machine to cut an aircraft wing section out of a solid billet, monitoring for a sudden occurrence that may happen only once in a year or two, recording data that can be reduced to graphs and tabulations without ever being touched by human hands? These and many more are described.

How significant is the fact that magnetic tape recording reproduces data in the same electrical form in which it was recorded? Enormously important, when you realize all the things the reproduced data can do that couldn't be done with the original signals or with the common forms of visual recording. For example the data can be slowed down to look at fast transients. It can be speeded up for wave analysis. It can be read out in any form. A tabular comparison between original signals and taped signals gives the full story. And a step-by-step pictorial demonstration of magnetic tape recording and reproduction puts the electrical-data idea into tangible, easily visualized form.

What does the data on magnetic tape look like? You can't see it, but the brochure will give you an idea of what it would be like if you could. And incidentally this may help to clarify the differences between various magnetic-tape-recording techniques.

Do you talk in tape's language? When is a tape recorder not a recorder? What is the difference between a channel and a track? What is a servo speed control? A much needed glossary gives the consensus of our views on terms.

For whom did we write this booklet . . . the expert, or the man for whom the whole subject is new? Both. It is written and illustrated so that any engineer or technically trained person can readily grasp the concepts and gain a broad understanding of the subject. If you are one of those who has already worked extensively with tape, you will find some new twists in the way the subject is explained, and perhaps ideas on new areas you hadn't explored. And incidentally, a copy of this brochure in some handy file will give you a good start in indoctrinating that new man in the department.

For your copy, write us today on your company's letterhead. Address your request to Department M-5

INSTRUMENTATION DIVISION
AMPEX CORPORATION

FIRST IN MAGNETIC TAPE INSTRUMENTATION

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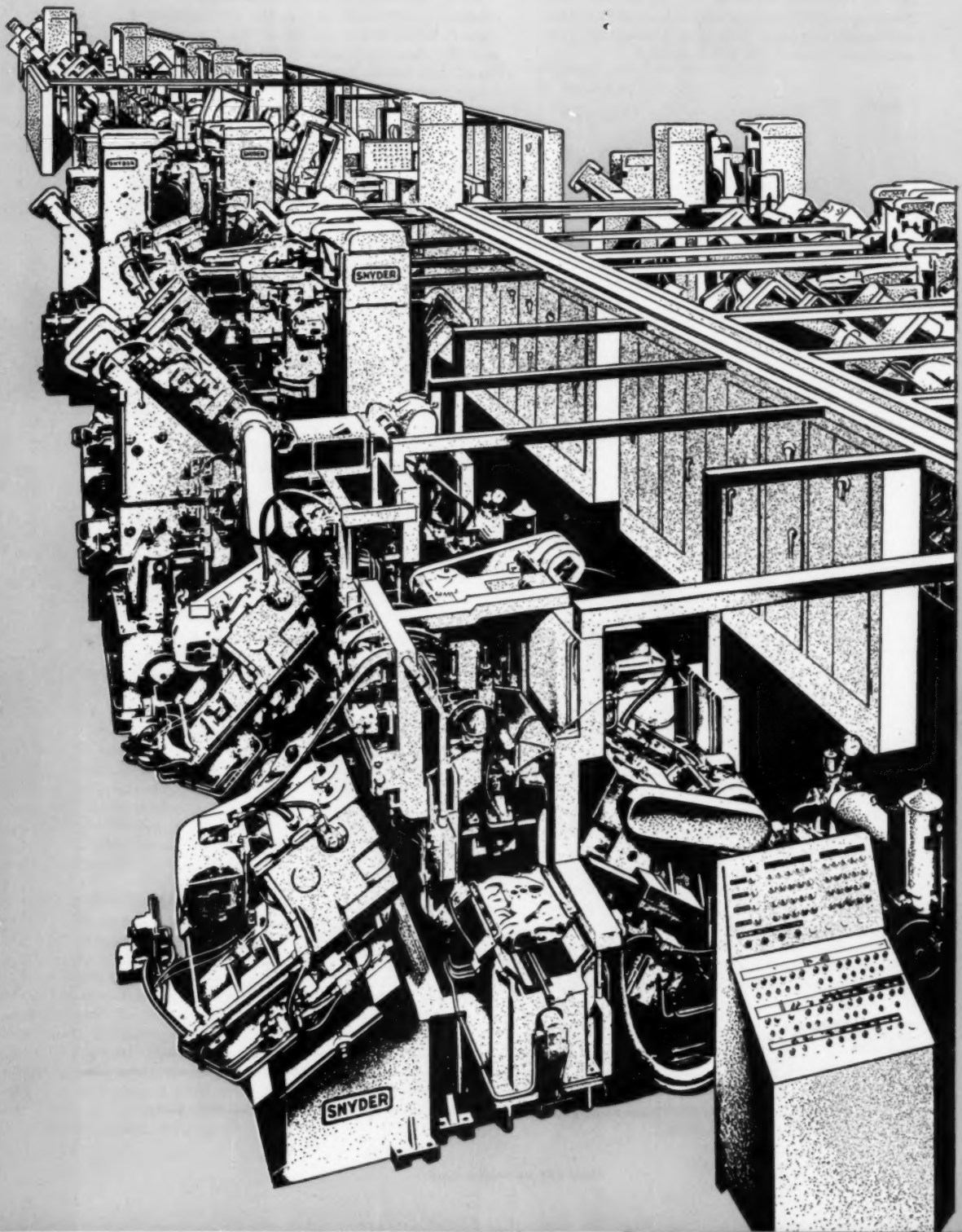
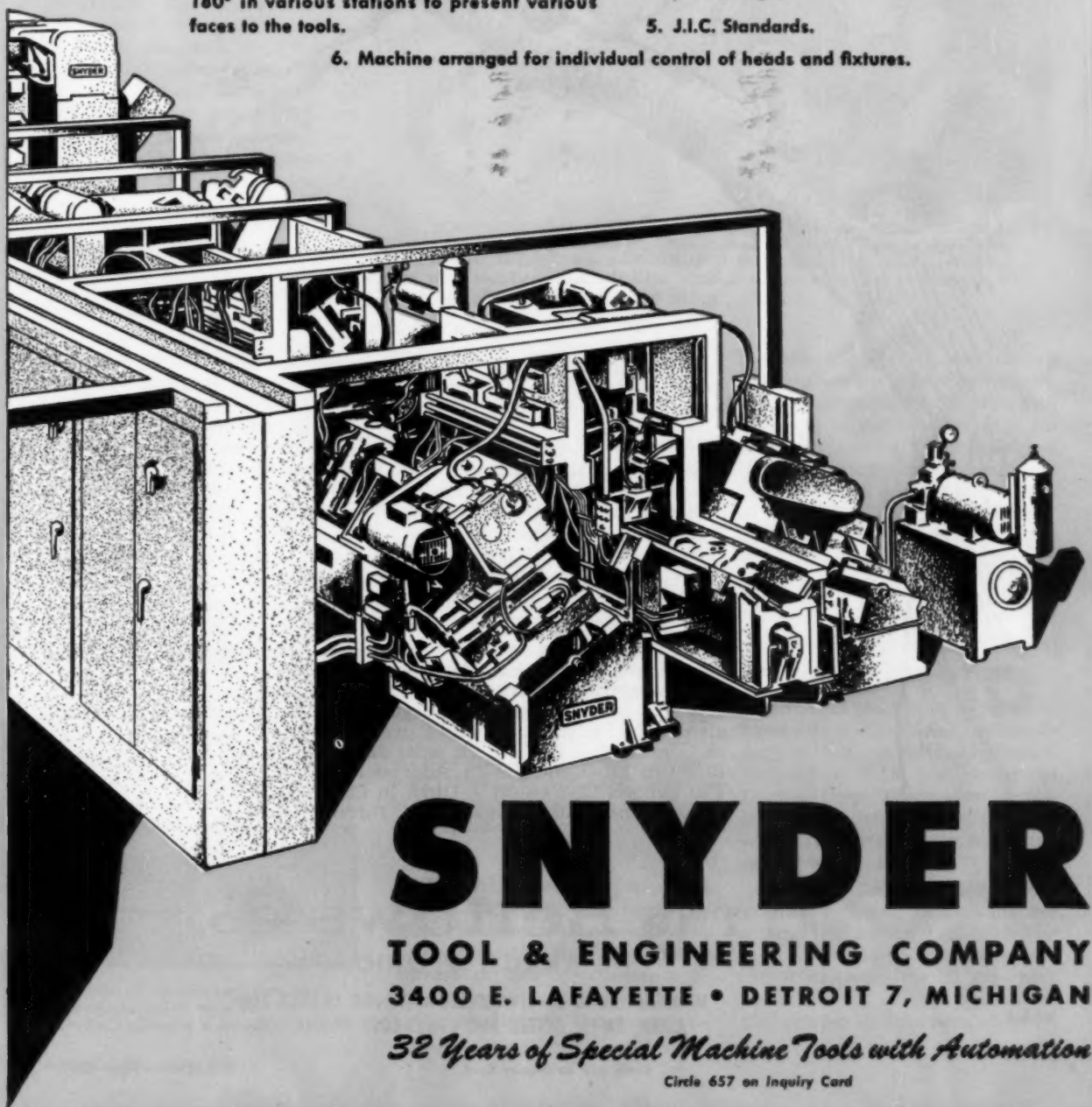


Transfer Machines Processes Either Castings from Rough to Finished Parts

Combination of two special transfer milling machines in parallel, with automation, feeding into one special transfer drilling machine gives production of 136 pieces per hour

Special Features of Snyder Machines Nos. 55-60 and 55-61

1. Machine line handles two or four barrel manifolds, random intermixed; sensing devices automatically instruct the proper drilling and tapping units.
2. Part rotated vertically 180° and horizontally 180° in various stations to present various faces to the tools.
3. Individual electrical panels and hydraulic units for each segment.
4. Wing bases, sections, spacers and risers standard throughout for easy adaptation to future part changes.
5. J.I.C. Standards.
6. Machine arranged for individual control of heads and fixtures.



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TOOL & ENGINEERING COMPANY

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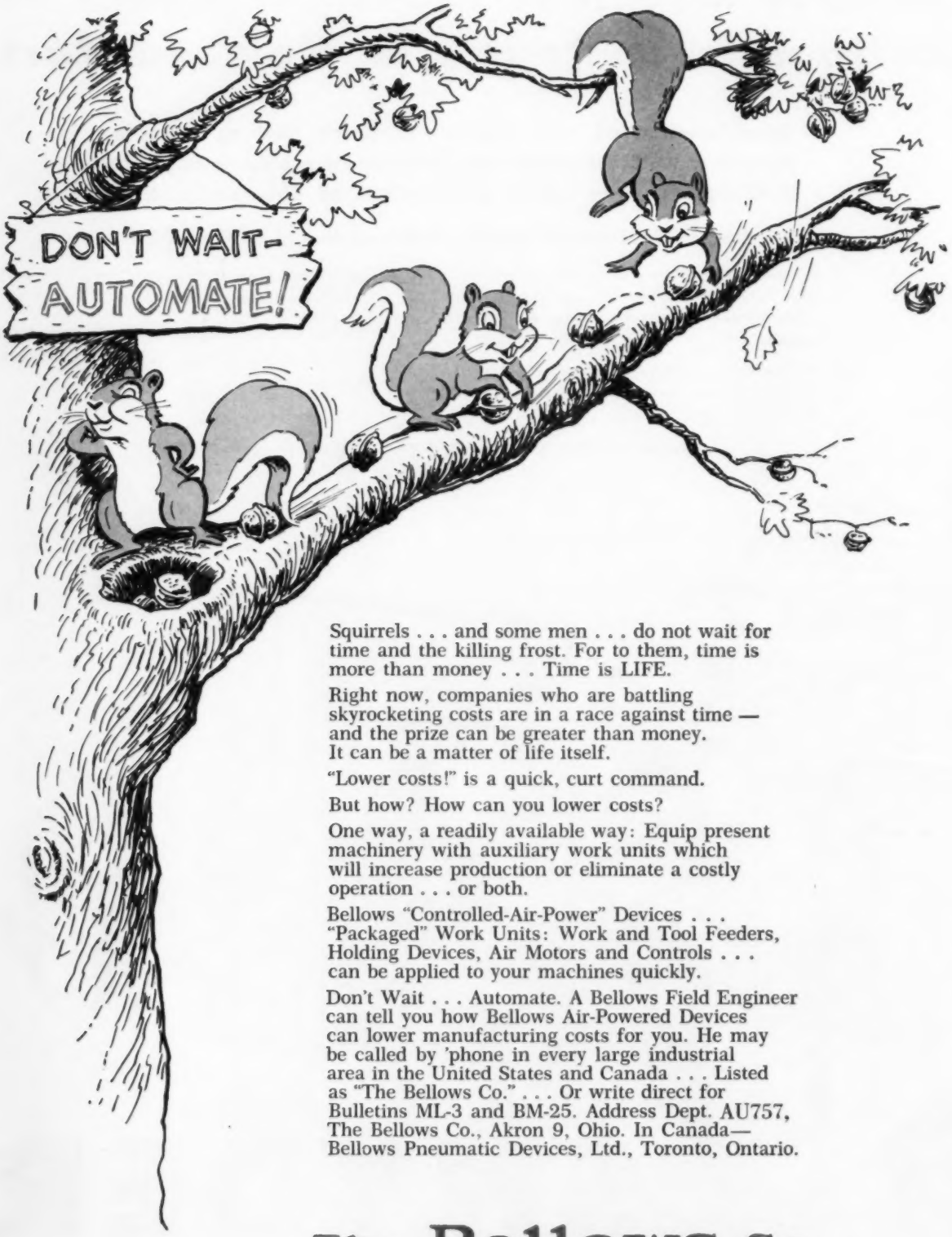

Squirrels . . . and some men . . . do not wait for time and the killing frost. For to them, time is more than money . . . Time is LIFE.

Right now, companies who are battling skyrocketing costs are in a race against time — and the prize can be greater than money. It can be a matter of life itself.

"Lower costs!" is a quick, curt command.

But how? How can you lower costs?

One way, a readily available way: Equip present machinery with auxiliary work units which will increase production or eliminate a costly operation . . . or both.

Bellows "Controlled-Air-Power" Devices . . . "Packaged" Work Units: Work and Tool Feeders, Holding Devices, Air Motors and Controls . . . can be applied to your machines quickly.

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AUTOMATION news

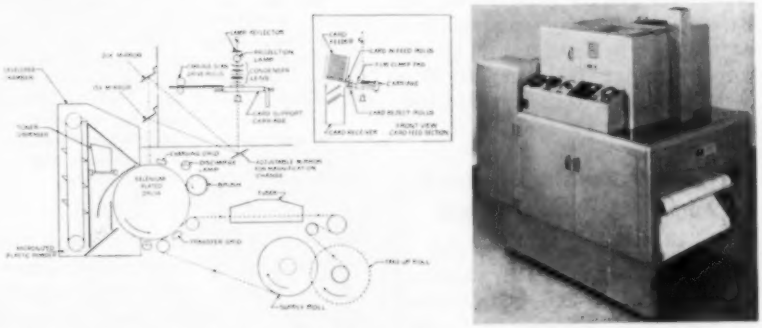
Today's events and developments in the field of automation

Card Mounted Microfilm Fed To Continuous Printer

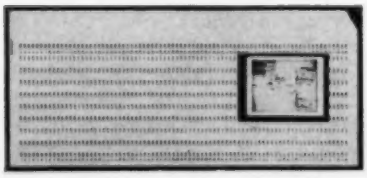
ENLARGED engineering drawings are produced automatically from microfilm mounted on punched cards. Developed by the Haloid Co., printer operation is based on the principles of xerography, an electrostatic copying process. Microfilmed image is projected through a lens system onto a 24-inch wide, rotating drum whose selenium coated surface has been positively charged to make it photoconductive. Where projected light strikes the drum, the charge is drained away, but the positive polarity remains in areas shielded by the opaque image on the microfilm, thereby forming a latent image. This latent image is made visible by a cascaded, negatively charged, micronized plastic powder that adheres to the drum wherever light did not hit. Transferring the resulting image to roll paper, whose travel is synchronized to the speed of the drum, is accomplished by the same electrostatic principle, only it is the paper that is positively charged and this draws the negatively charged powder image from the drum to form the print. The powder is fused permanently to the paper by heat. The printing process is completely automatic.

Individual microfilm frames are mounted in die-cut apertures of punched cards which can be sorted for various purposes by card handling machines. Once sorted the cards emerge from the printer in the order of entry. Up to 400 prints of a single film may be obtained via pushbutton that repeats the exposure.

The apertures in the cards are die-cut, framed with adhesive, and mounted automatically with individual microfilm frames by the Filmsort Div. of the Dexter Folder Co. Microfilming is done by the Recordak Corp. and Remington Rand. The equipment has been developed for the Navy Bureau of Aeronautics to furnish thousands of potential suppliers with necessary drawings and specification sheets when invitations for bids are published.



CONTINUOUS printer developed by the Haloid Co. combines xerography, an electrostatic copying process, and microfilms mounted on punched cards in reproducing drawings at a speed of 20 ft a minute. With an auxiliary attachment, roll microfilm may also be used. Finished drawings can be cut to size automatically if desired.



SAMPLE of aperture card from which continuous printer turns out dry, enlarged engineering drawings.

NATIONAL Electrical Manufacturers Association has formed a special informational committee to keep industry and the public abreast of new developments in the semiconductor field.

Organization of the special informational committee has stemmed from discussions within the association's Semiconductor Rectifier Section, and in the semiconductor industry in general which developed a feeling that all semiconductor manufacturers are not fully aware of the many services offered by NEMA and the benefits to be derived from co-operative activity in the association.

Grinder Control Permits Production of Mating Parts

GRINDING the OD of parts to fit bores is accomplished automatically with a control system manufactured by EAM Div., Industrial Gauges Corp. The control, which can be applied to most grinders, eliminates the necessity for match gaging or selecting fits.

In operation, the part to be ground is placed in grinding position. The mating part with finished ID is placed on a gaging anvil. If necessary the ID gage may be located up to 5 ft away from the grinder to take care of large,

unwieldy pieces. The grinding proceeds automatically until the workpiece is ground to fit, with no manual gage readings being required during the operation. The control unit dispenses with the necessity of making the usual mechanical settings on a grinder or resetting for wheel wear. Backlash is electronically compensated.

The ID gaging attachment can be disconnected from the control, converting the unit into a system for controlling the grinding of a series of pieces to an identical size.

Portable Automatic Equipment Reclaims Fire Damaged Cans

CANNED food reclaiming line to rehabilitate canned goods damaged by fire or water has been designed by Magnuson Engineers Inc. Previously, fire damaged cans were recovered by hand washing to loosen charred labels, followed by manual polishing and drying operations. Using this method, 50 people averaged approximately 12,000 cans a day. The automated reclaiming line can do a better reclaiming job at rates up to 28,800 cans per 8-hour shift.

The reclaiming line consists of four separate units which can be trucked to the point where damaged cans are located. The four elements are: (1) Unit which brushes off and washes away damaged labels; (2) electrolytic tank in which the cans are immersed in a special solution and subjected to an electrocleaning operation which lifts rust and other material off the can itself without impairing the can's protective tin coating; (3) unit in which the cans are brushed off by spinning nickel silver brushes under a fresh water spray to polish the cans to a bright luster; and (4) can dryer which removes all moisture from the cans. Cans are then inspected and relabeled.

Claude M. Westerman, chief engineer of Lansing B. Warner Inc., managers of Canners Exchange which insures most of the nation's food processors, declared: "It has been our object in purchasing this machine, to be able to lower insurance costs of our policy holders through reducing the loss on canned foods involved in cannery fires by increasing their salvageability. We are now able to quickly begin salvage operations anywhere fire strikes in the U.S. or Canada."

DESIGNED for miniaturized instrumentation, a small electronic device which converts signals directly to readable characters has been announced by the Electronic Tube Div., Burroughs Corp. A miniature NIXIE is a gas-filled, cold cathode, 10-digit numerical indicator tube having a common anode. Numerals formed on the readout device are clearly visible at 10 ft, and the unit can be used for such applications as aircraft instrument panels, computers, industrial control panels, counters, digital voltmeters and various meters.

Automation's J. C. Keebler Appointed Managing Editor

EMPHASIZING the continual growth of the magazine with which he has been associated since its founding, **James C. Keebler** has been appointed managing editor, AUTOMATION. The promotion recognizes Jim's contributions both to the day-by-day task of publishing a technical magazine and to the challenging problems of planning and shaping a magazine in accordance with industry's needs.

His ability to interpret technical subjects for AUTOMATION's readers is based upon a real appreciation of industry's manufacturing and production problems. Prior to joining the staff of AUTOMATION, Jim spent approximately 8 years in production engineering work at Thompson Products Inc. His experience included assignments as tool designer, tool design supervisor, process planning supervisor, and manufacturing engineer in the field of precision aircraft, automotive, and appliance parts and components. The intertwined formal education and military experience which he has accumulated is typical, in some respects, of his generation. The highlights: Bachelor of Science in Mechanical Engineering, Purdue University; Navy training schools at Columbia, Harvard and Bayonne; a stint in the Philippines as ensign in the Naval Supply Corps; and Master of Science in Mechanical Engineering, Case Institute of Technology. He is a member of the American Society of Mechanical Engineers, American Society of Tool Engineers, Tau Beta Pi, and Pi Tau Sigma.

Jim is devoted to AUTOMATION, the magazine, and automation, the concept, but there are other important things in his life: His family, which includes three little Keeblers; and a 100-year-old homestead, which is being transformed into a modern home as an avocation shared by his wife.

Joint Control Council Formed

AUTHORIZED representatives of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Institute of Radio Engineers, the Instrument Society of America and the American Institute of Chemical Engineers have formed a joint council to be concerned with the broad field of control systems engineering.

Two initial objectives outlined by the delegates are: Co-operation in the organization and operation of a proposed international federation of control systems engineering; and co-ordination of the professional activities, meetings, conferences, symposia, and joint control meetings of American technical societies. **Dr. Rufus**

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CCC's roster of satisfied customers reads like a bluebook of industry. If your company is planning an expansion or alteration program, CCC will do the job quickly, economically, efficiently . . . for CCC "has know-how, will travel."

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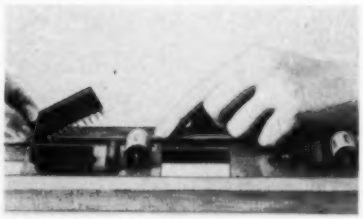
Oldenburger, chairman of the Instruments & Regulators Div. of the American Society of Mechanical Engineers, has been elected chairman of the council.

Don't Ignore Creative Ability

AMERICAN industry is concentrating so much effort on getting college trained engineers, regardless of their creative abilities, that much of the country's inventive talent is being wasted, according to **Carl G. Sontheimer,** executive vice president of CGS Laboratories Inc. He points out that if Thomas A. Edison and the Wright brothers were 20 years old today, they would have great difficulty in finding technical positions worthy of their talents.

"Most companies largely ignore the creative mentality in selecting young engineers," Sontheimer said, "and if a young engineer is creative, his initiative and inventiveness may be stifled rapidly in the organization of the average industrial corporation. There are now many research problems which can be solved only by teams of men with scientific training, but the day of the 'attic inventor' is not past in electronic development.

"We feel that a man who has made electronics a hobby since his early teens is in general a better bet, degree or not, than a college trained boy who took electronics simply because he heard it was a sure way to make a living. Naturally the former boy hobbyist who has acquired a sound fundamental scientific education is most valuable to our kind of organization."



DESIGNED for use with printed wiring applications, custom-designed preassembled package of components is available from Jeffers Electronics Div. of Speer Carbon Co. Available components include tubular ceramic capacitors and fixed composition resistors. The components are mounted on clips, which resemble fuse clips, then soldered. The complete assembly is coated with a thermosetting plastic and vacuum impregnated with microcrystalline wax, for maximum protection against adverse atmospheric conditions. Center-to-center spacing between components is 0.200-inch and the maximum number of components in a single package is limited only by the length of the strip considered practical to use.

Device Locates and Reads Filmed Copy of Punched Cards

NATIONAL Bureau of Standards has completed FOSDIC II—a high-speed electronic device that can read microfilmed copies of punched cards and search for cards containing specific information. The unit is an extension of the work which resulted in an earlier device to read microfilmed census documents. Sponsored by the Weather Bureau, the present machine is designed to aid in the high-speed processing of weather data contained on over 300 million punched cards at the Weather Records Center in Asheville, N. C. The device was developed by **M. L. Greenough** and **E. C. Palasky.**

The input to the scanning device

Purdue Automation Conference Session Topics Announced

INITIAL program arrangements for the Second Conference on Manufacturing Automation have been completed. The listings of session topics climaxes a planning effort that began shortly after the completion of the highly successful first conference held in co-operation with Purdue University in 1956.

That initial conference had as its aim the establishment of a broad base on which to create understanding of the complex area of manufacturing automation. The forthcoming October conference, taking cognizance of the strides which have been made in the last year, has been built around the theme: Engineering the Automated Line. The specific topics, to be covered by leading industry spokesmen, were chosen because of the widespread and continually expressed interest in the general subject matter.

In addition to the talk-question and answer presentation which is well suited to development of theory and broad understanding, the conference will also cater to those conferees who hope to gain detailed information about specific current problems. To allow extensive participation by all conferees, the afternoon of two days has been set aside for round table discussions. Leaders of the discussion groups will represent a wide variety of industries. When this expert knowledge is combined with the experience of the conferees the proper climate will have been created in which exchange of information essential to the furtherance of practical manufacturing automation can flourish. Future issues of AUTOMATION will elaborate upon the program and introduce the speakers and discussion leaders to AUTOMATION's readers.

SECOND CONFERENCE ON MANUFACTURING AUTOMATION
Theme: Engineering the Automated Line
Purdue University, October 7, 8, 9

Session Topics

Planning Automatic Line Production

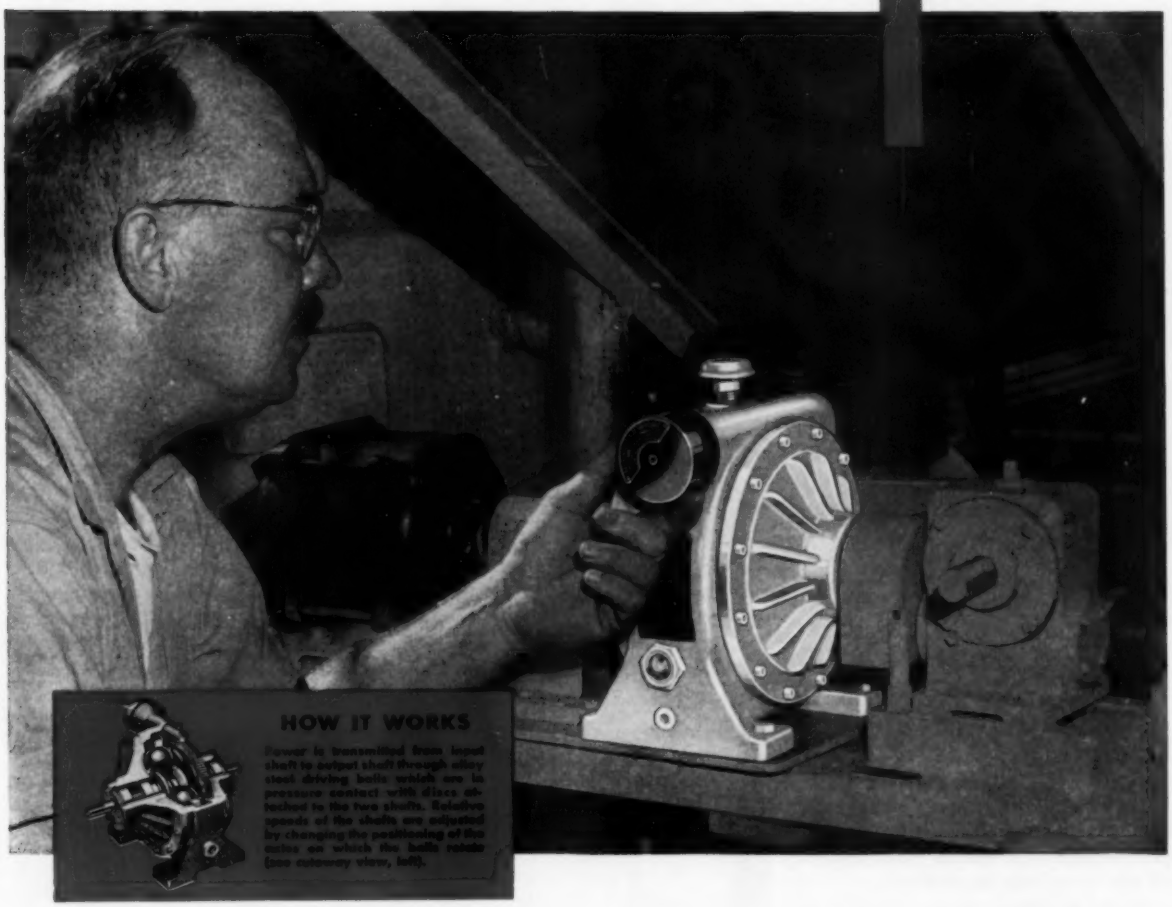
Developing the Integrated Line	Process Control
Estimating Special Equipment Costs	Numerical Control
Comparing Machine Cost and Time Factors	Banquet—Automation in the National Eye
How to Figure Payoff	Automatically Handling Parts In Process
Gaging Control	Economics of Automatic Assembly

Orienting and Placing Small Parts for Assembly

Afternoon sessions of second and third days will be devoted to round-table discussions—subjects to be announced.

Major chemical producer meters flow of catalytic agents with Cleveland Speed Variator

A chemical research worker adjusts the manual control knob on the Cleveland Speed Variator to set the metering speed. Various types of regulating mechanisms can be mounted on the Variator to provide automatic adjustment by remote control.



IN the research department of a major chemical plant, catalytic agents are metered and their flow varied with precision accuracy. This control is exercised with a Cleveland Speed Variator.

A ¼-horsepower electric motor is connected to the Cleveland Speed Variator driving a pump through a 25-1 speed reducer. Being infinitely variable, the Variator gives stepless speeds over its full 9:1 range—from ⅓ to 3 times input speed. Pumping speed can be varied from 207 to 23 rpm. This provides the necessary speed range for metering the various types of catalytic agents.

Available in eighteen standard types and sizes, the Cleveland Speed Variator offers these major advantages: 1. An extremely compact unit; 2. Almost any input speed up to 1800 rpm—clockwise or counterclockwise; 3. Constant horsepower output over a 9:1 range, or constant output torque with a 6:1 range; 4. Infinitely variable over entire speed range; 5. Rapid response to speed change, precise adjustment, accurate maintenance of settings; 6. Long life and minimum maintenance; 7. Ample bearing support for overhung pulleys on either input or output shafts.

Write for Bulletin K-200 for detailed description of the Cleveland Speed Variator, with photographs, sectional drawings, rating tables and specifications.

THE CLEVELAND WORM AND GEAR COMPANY

Speed Variator Division, 3265 East 80th St., Cleveland 4, Ohio

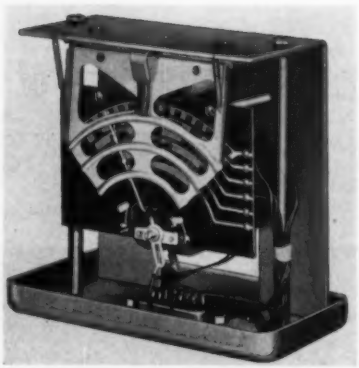
Sales representatives in all major industrial markets. In Canada—Peacock Brothers Limited.

is in the form of 16 mm microfilm. Each 100-ft roll contains up to 13,000 images of punched cards. The film is prepared in a special microfilm camera which films the cards against a background scale which provides for an indexing operation when reading and searching for the columns on the cards.

In operation, the machine searches for images to match previously programmed information introduced into the system through a plugboard. To meet the particular requirements of the contemplated use of the equipment, card selection is based upon the contents of ten of the 80 columns contained on a card. Film is read as it passes by a scanning head, with the ten selected columns in each image being read and stored in a memory of 120 bits. At the end of a scan, the memory contents are compared to the plugboard pattern. When agreement is found, a rapid response brake stops film movement, leaving the selected image within the field of view. The image is then scanned again in its entirety, feeding a reproducing card punch to create a new card identical to that of the film. Thereafter the searching process resumes until the next match occurs. Searching rate is over 4000 cards per minute for a ten-column field, but readout to the card punch is reduced to 100 per minute to match the speed of the punching machinery.

There is good evidence that the searching speed of the present device can be raised considerably without appreciable loss of reliability. There is the possibility of modifying the scanning technique to provide an information retrieval machine that searches filmed documents accompanied by coded punched cards. Photographic, rather than electrical copying of the data might then be employed.

SEVERAL management changes have been announced by **Louis Polk,** president of the Sheffield Corp. **O. A. Ahlers,** senior vice president, has been given the overall direction of the Machine Tool, Contract Manufacturing and



UNIQUE control instrument, functioning both as an analog-to-digital converter and as a multicontact meter relay has been developed by Assembly Products Inc. The instrument contains a printed circuit scale instead of a normal dial, and a pointer which is positioned over the scale in proportion to an input signal. An output signal can be obtained when a readout coil, energized either manually or automatically, pulls a pusher bar and the pointer down on the scale. It can be operated from typical sensing elements such as thermocouples, ion gages, differential transformers, strain gages, or photocells.

Threadwell-Conway Tap and Die Product Divisions. **W. Fay Aller,** previously vice president of the Autometrology Div., is appointed vice president to supervise and coordinate the company's Autometrology, Standard Production Instruments and Fixed Gage and Inspection Instruments Divisions. **J. T. Welch** has been named assistant vice president for co-ordinating the operations of the company's national field sales organizations. Welch will report to **C. H. Reynolds,** senior vice president, who also will have charge of the company's manufacturing facilities in Mt. Clemens, Mich., Cleveland, O., and Windsor, Ontario, Canada. **William I. Wilt** has been advanced to assistant vice president of the Standard Production Instrument Div.

New Field For Machinery Builder

FORMATION of the Plastics Machinery Div. has been announced by National Automatic Tool Co. Inc. The division, which will produce plastics injection molding machines, takes Natco into a new field and marks a major diversification move for the firm. Heading the Plastics Machinery Div. are **Russell W. Powell,** sales manager, and **Richard M. Norman,** chief engineer. According to **N. M. Forsythe,** Natco vice president and general manager, formation of the division results from an extensive two-year program of preparation. The plastics field was chosen primarily because of the growth ex-

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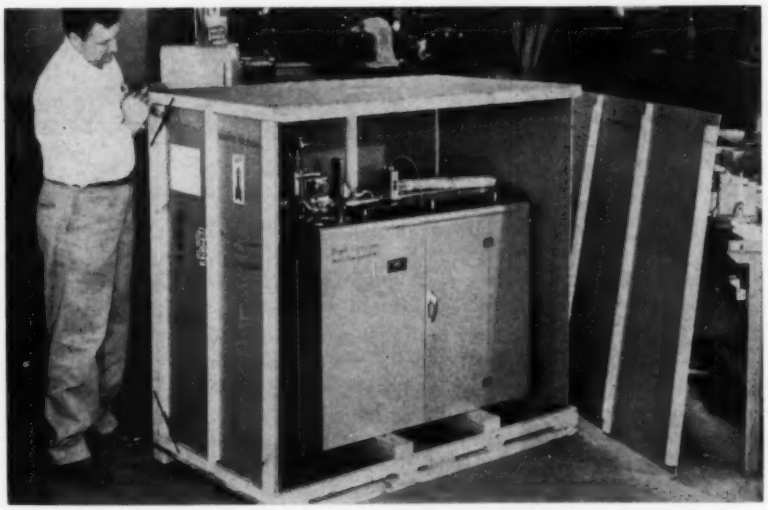
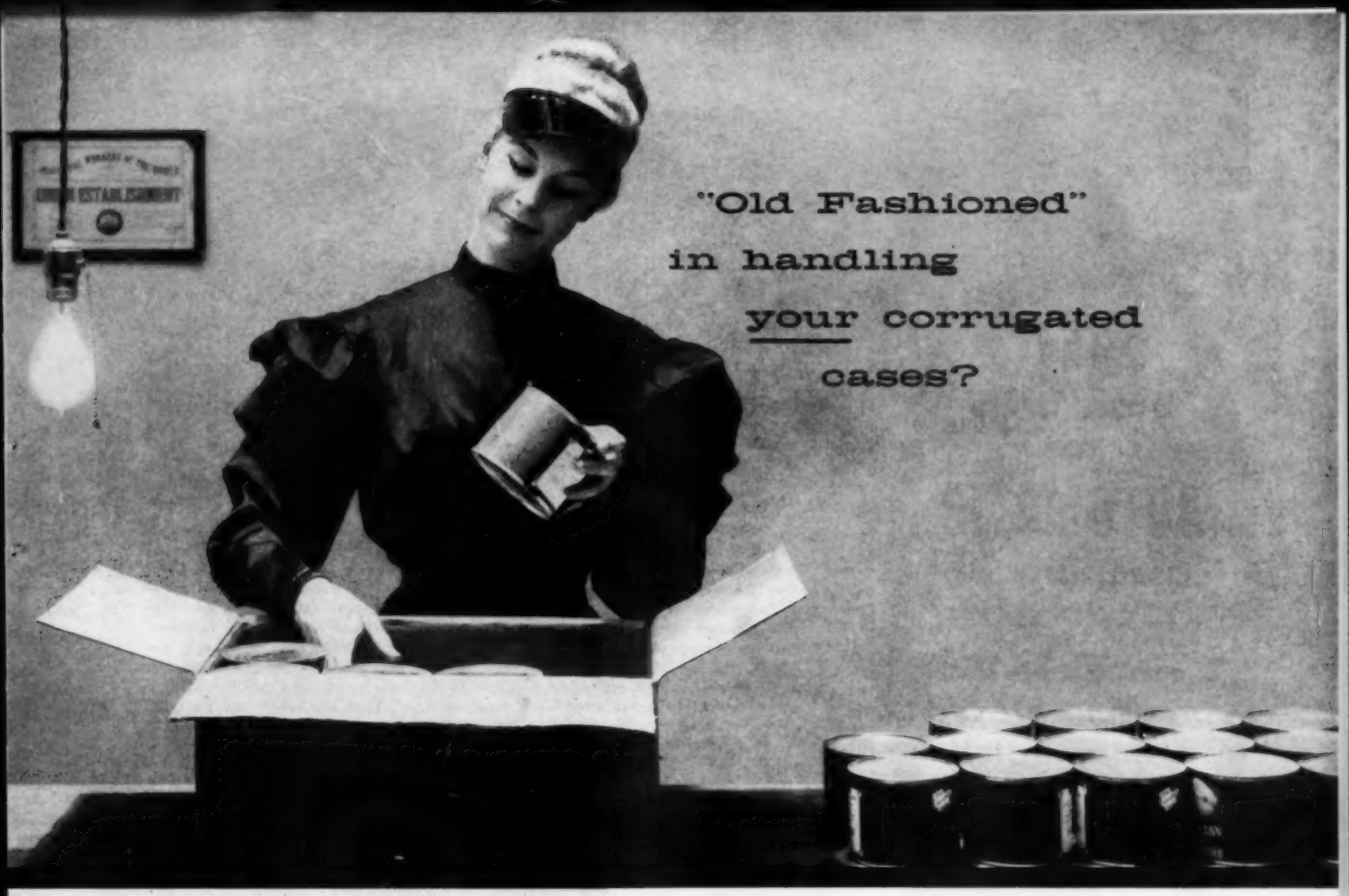
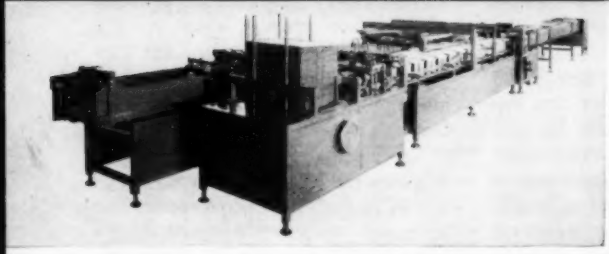


SHIPPING container which uses no nails in setup, can be shipped and stored knocked down, has interchangeable parts, and can be built with a pallet base as an integral part of the container itself, has been designed by the Evans Container Corp. The containers are assembled, locked and braced in a simple operation by inserting a tubular metal spindle into angular slots that are cut into panel corners of each container. A workman can assemble a container around a kitchen stove in less than 2 minutes and the container can be removed from the product for inspection in about half that time. The container is reusable and can be constructed of any panel material ordinarily used, such as fiberboard, plywood, or wood. Individual panels that are damaged or worn can be replaced.

Circle 661 on Inquiry Card→





PACKOMATIC GALLON-CAN CASE LOADER

Packomatics high-speed, continuous-motion case forming, feeding, loading and sealing machine, shown above, oiled the way at the Esso Standard Oil Company plant for faster fully-automatic casing of gallon cans. This is the only machine on the market designed for cost-reducing end-loading style corrugated shipping containers. Custom-Engineered to accomodate cans from the 12 oz. size to the 5-qt. Imperial gallon size, for an almost endless variety of products—from foods, juices and beer to paint, chemicals and cleansers.

J. L. FERGUSON CO. Joliet 2, Ill.

New York, Chicago, Cleveland, Boston, Tampa, Baltimore, Portland, Denver, Los Angeles, San Francisco, Seattle, New Orleans, Louisville, Kansas City and All Principal Canadian Cities.

PACKOMATIC machines include the Bale Sealer — Case Sealers — Opener-Loaders — Case Imprinters — Telescoping Volumetric Filler — Packer-Gluers. Units available, semi-automatic or fully-automatic depending on your needs.

Packomatic

T.M. Reg. U. S. Pat. Off.

equipment feeds, forms, positions, loads, seals, and imprints shipping containers automatically

Just stack the magazines with "knocked-down" containers. The rest is automatic. With Packomatic Custom-Engineered equipment, containers are fed out, formed and positioned, end-loaded with cartons or cans, sealed and imprinted 4-sides (serial numbered, if desired) ready for shipment. Packomatics do the whole job—or any part of it. And how they pay off in any plant! End-loaded cases require up to 28% less board. Labor costs shrink dramatically and your packaging line keeps pace with your production line. Your Packomatic line can grow as you grow, too. Start now with a case opener and loader, or case sealer, or imprinter—build it unit by unit into a complete system.

Six 5-qt. cans or gallon cans in 20⅛" x 13⅛" x 9 3/16" case and 20¼" x 13¾" x 8¼" case

Twelve 46 oz. cans in 21" x 13" x 7⅛" case

Twenty-four cartons in 12½" x 10⅝" x 8½" case

Eighteen 7 & 8 oz. cartons in 20" x 14⅜" x 8⅝" case

Sixty cigarette cartons King Size: 17⅛" x 11½" x 22" Regular: 14 13/16" x 11½" x 22"

TYPICAL CASE LOADING PATTERNS FOR CANS AND CARTONS

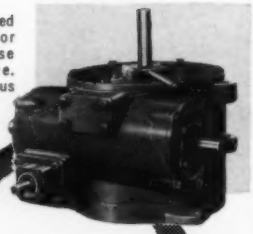
Twenty-four 12 oz. cans in 16⅜" x 10 11/16" x 5 5/16" case

Six No. 10 cans in 22 1/16" x 17⅜" x 7⅛" case

Thirty 1 lb. cartons in 16⅛" x 10 1/16" x 7¼" case

Twenty-four cartons in 19½" x 10⅜" x 7" case

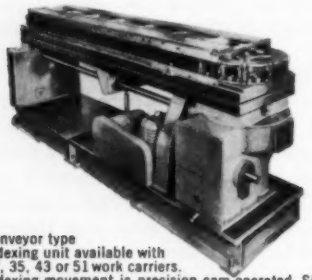
Forty-eight cartons in 22¾" x 23½" x 15⅛" case



Basic cam-operated indexing unit for special purpose machine drive. Available in various sizes.

The basic units for AUTOMATIC assembly or production ...Standard Tool precision, proved cam-operated indexing units.

Basic cam-operated indexing unit incorporated in standard table with mechanical locking arrangement, timer and drive.



Conveyor type indexing unit available with 27, 35, 43 or 51 work carriers. Indexing movement is precision cam-operated. Side and top machine surfaces allow for ease of tool mounting. Furnished complete with drive.

1. *Reduces design time.*
2. *Permits rapid re-tooling when necessary.*
3. *Wide range of sizes and indexing increments.*

Standard Tool indexing units provide smooth, accurate positioning between automatic production stations. They are built for heavy duty operation and furnish the basic requirement for profitable automation. Engineers at Standard Tool are skilled in manufacture of completely automatic assembly and production machinery into which these indexing units are incorporated. Your inquiries will receive prompt, competent acknowledgement.

STANDARD TOOL & MANUFACTURING CO.

Creative Machine Designers and Builders Since 1910 » » « «

KEARNY, NEW JERSEY

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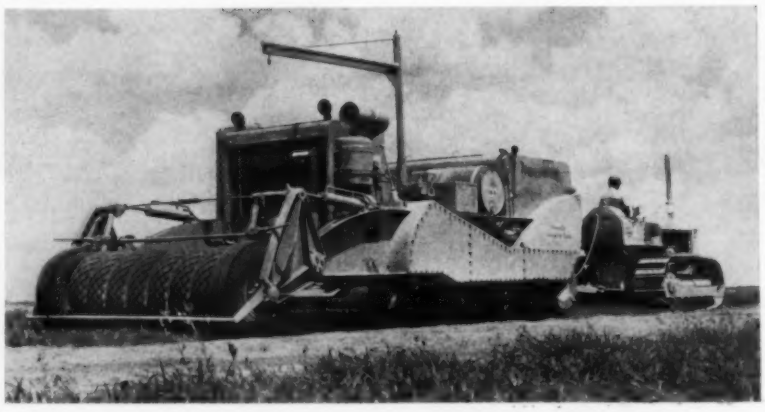

MULTIPURPOSE machine which completely prepares and conditions soil, plants seed and packs earth in a one-pass operation has been developed by the Norton Portland Corp. The unit will be manufactured by the Todd Shipyards Corp. The 12-ton machine, called the Wonsover, is towed by a tractor. A control panel on the tractor is attached to the Wonsover by an extension cord, and pushbuttons on the panel enable the driver of the tractor to control the machine functions. The machine prepares land in strips 8 feet wide, and, depending upon soil conditions, can cover 2 to 5 acres per hour. In one pass over the land, machine can add lime or fertilizer and other chemicals to the soil, prepare the soil in depth to a maximum of 10 inches, smooth the conditioned soil, place the seeds, and pack the soil over the seeds. Preparation of the soil is so thorough that when attached to the rear of a harvester, a new crop can be planted while a preceding crop is being harvested.

hibited by the plastics industry for the past several years. In addition, injection molding machines and Natco metal cutting machines are both hydraulically operated; production of the two lines could easily be co-ordinated in the existing manufacturing plant by providing for space and additional tooling; and plastic machinery is used by a large composite of manufacturers dealing in very diversified consumer products, many new to the buying public.

Tramp Metal Detector For Textile and Plastic Industries

METAL DETECTOR which has been specially developed for continuous inspection of textile fabrics during production has been announced by the Radio Corp. of America. The detector is capable of spotting specks of stray metal as small as a typewritten dot, according to **Harold M. Emlein,** manager, RCA Theatre and Industrial Products Dept., and provides continuous inspection of strip material traveling at speeds ranging from 10 to 1000 feet per minute. The inspector reacts to all types of metals, magnetic and nonmagnetic and can be installed so that upon detection it will trigger an alarm system and stop the production line. Contaminated areas can be automatically marked with chalk or dye.

The electronic equipment includes an inspection aperture 64 inches wide and 1⅛ inches high through which passes the material to be checked. This size aperture will accommodate fabrics up to 60 inches in width. Machine operation is based upon specially designed coils which produce a high frequency electromagnetic field. The sensitivity of the equipment can be adjusted to detect extremely small metal particles even though deeply embedded in the material under inspection. Tramp metal distorts the field and in turn creates an electrical signal which is fed to a control unit where it is amplified and used to trigger the alarm system. Equipment can also be used for continuous inspection of plastics processed in sheet form.

STANDARDS Committee of the IRE has listed various definitions which should be of general interest. Among these standard definitions are:

Electron device — A device in which conduction is principally by electrons moving through a vacuum, gas or semiconductor.

Electron tube—An electron de-

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407	437	467	497	527	557	587	617	647	677	707	737	767	797
408	438	468	498	528	558	588	618	648	678	708	738	768	798
409	439	469	499	529	559	589	619	649	679	709	739	769	799
410	440	470	500	530	560	590	620	650	680	710	740	770	800
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412	442	472	502	532	562	592	622	652	682	712	742	772	802
413	443	473	503	533	563	593	623	653	683	713	743	773	803
414	444	474	504	534	564	594	624	654	684	714	744	774	804
415	445	475	505	535	565	595	625	655	685	715	745	775	805
416	446	476	506	536	566	596	626	656	686	716	746	776	806
417	447	477	507	537	567	597	627	657	687	717	747	777	807
418	448	478	508	538	568	598	628	658	688	718	748	778	808
419	449	479	509	539	569	599	629	659	689	719	749	779	809
420	450	480	510	540	570	600	630	660	690	720	750	780	810
421	451	481	511	541	571	601	631	661	691	721	751	781	811
422	452	482	512	542	572	602	632	662	692	722	752	782	812
423	453	483	513	543	573	603	633	663	693	723	753	783	813
424	454	484	514	544	574	604	634	664	694	724	754	784	814
425	455	485	515	545	575	605	635	665	695	725	755	785	815
426	456	486	516	546	576	606	636	666	696	726	756	786	816
427	457	487	517	547	577	607	637	667	697	727	757	787	817
428	458	488	518	548	578	608	638	668	698	728	758	788	818
429	459	489	519	549	579	609	639	669	699	729	759	789	819
430	460	490	520	550	580	610	640	670	700	730	760	790	820

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For additional free information circle item number on an inquiry card. Fill in your name, title, address, etc.—Drop it in the mail—No Postage Required—Your request will receive prompt attention and will be filled directly by the manufacturer.

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vice in which conduction takes place by electrons moving through a vacuum or gaseous medium within a gas-tight envelope.

Electronic—Of or pertaining to devices, circuits or systems utilizing electron devices. Examples are electronic control, electronic equipment, electronic instrument, and electronic circuit.

Electronics—That field of science or engineering which deals with electron devices and their utilization.

Electronics (used as an adjective)—Signifies of or pertaining to the field of electronics. Examples are electronics engineer, electronics course, electronics laboratory, and electronics committee.

Redesigned Motor Line Permits Improved Production Facilities

REDESIGN of their line of ac induction motors rated in the 40 to 125 hp class has been announced by the General Electric Co. This completes a 5-year program of design changes for ac motors ranging from 1 to 125 hp in ratings.

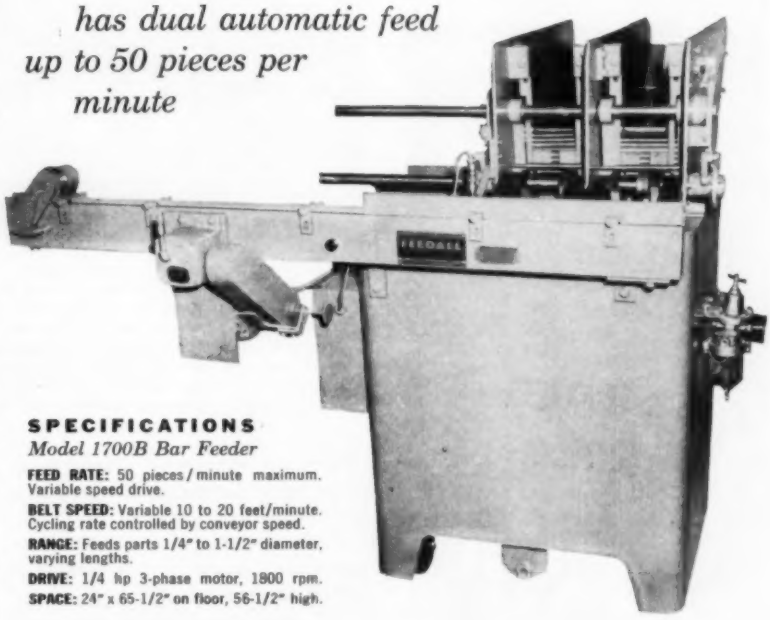
The redesign of the larger motors offered the company the opportunity to improve techniques used in production. Improvements are patterned after techniques established for smaller motors and include the use of tape controlled machine tools, more extensive use of computers, and application of other automatic machinery designed to give greater uniformity and closer tolerances during production. More than $11 million was spent on the program to redesign this latest motor line and to provide new and modern facilities for the manufacture of the items. The company reports that the design of the product was optimized not only with respect to motor characteristics but also with respect to material flow, machinability and processing. Inventory considerations were carefully scrutinized to assure a maximum ability to provide the customer with the exact motor to meet his requirements without unnecessary increases in inventory. As with the smaller motors, this was accomplished by a building block approach. Such a procedure permits satisfaction of customer needs

NEW AUTOMATIC

Feedall

BAR FEEDER

has dual automatic feed up to 50 pieces per minute



SPECIFICATIONS
Model 1700B Bar Feeder

FEED RATE: 50 pieces / minute maximum. Variable speed drive.
BELT SPEED: Variable 10 to 20 feet/minute. Cycling rate controlled by conveyor speed.
RANGE: Feeds parts 1/4" to 1-1/2" diameter, varying lengths.
DRIVE: 1/4 hp 3-phase motor, 1800 rpm.
SPACE: 24" x 65-1/2" on floor, 56-1/2" high.

Eliminates costly hand-feed with fast automatic production operation

The **high-speed output** of the Feedall 1700B means twice as many pieces fed per hour . . . **less cost** per unit . . . **larger** production capacity . . . **steady flow** of bars and tubing onto a conveyor belt at desired rate (cycling rate controlled by variable speed drive on belt) . . . full automatic operation of parts production machines and processes.

The secret is the unique double feed, which provides twice the capacity and twice the cost-saving of comparable single feeders. When installed on centerless grinders, polishing machines and heat-treat equipment, the 1700B handles a wide range of parts lengths, diameters and feed rates. And operating reliability is unsurpassed.

There's extra economy, too, in the simple "complete-package" design. The unit is self-contained, occupies only minimum floor space.

The all-important details of cost-saving automatic feed with Feedall machines are presented in the latest catalog, complete with estimate data sheet. Write for your copy . . . or send us sample parts you want to feed and include brief data. We'll do the rest, promptly.

Feedall *Producers of automatic feeding devices*
FEEDALL, INC., WILLOUGHBY, OHIO

ELEVATING, BLADE, TUMBLE, VIBRATORY FEEDERS • TRANSFER AND ELEVATING CONVEYORS • SPECIAL SELECTOR DEVICES

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RCA SPECIAL RED

ELECTRON TUBES

RCA-5690—full-wave vacuum rectifier
RCA-5691—high-mu twin triode
RCA-5692—medium-mu twin triode
RCA-5693—sharp-cutoff pentode

10,000 hours minimum life*!—one of the many important reasons why RCA "Special Reds" are so often specified. The following features of RCA "Special Reds" add up to *extraordinary reliability*—essential to continuous production where electronic controls are in use:

• Extra-long life • Exceptional stability throughout life • Extreme uniformity of characteristics from tube to tube • High resistance to shock and vibration • Selected high-quality materials and superior workmanship.

RCA "Special Reds" are available through your RCA Industrial Tube Distributor. Contact him today for the booklet "RCA Receiving Tubes for Industry and Communications."

*Or two years service after initial use (whichever occurs first) when used within ratings.

RCA TUBES FOR INDUSTRY
RADIO CORPORATION OF AMERICA
Tube Division Harrison, N. J.

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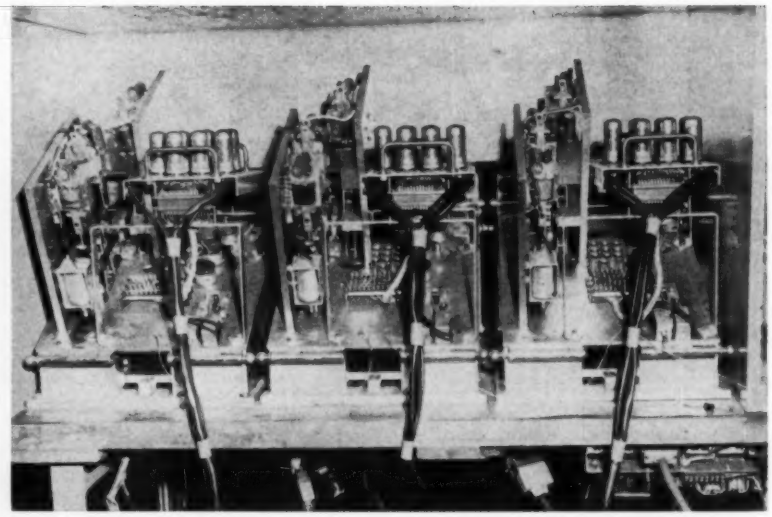


AUTOMATIC tester has been designed and built by Victor Adding Machine Co. for the simultaneous testing of three automatic printing calculators. Machines to be tested are placed beneath solenoid-operated "fingers" which enter test problems into the calculator keyboards. This rear view of the three test positions shows a plug-in relay, the test position base and the control unit. The solenoids are activated by electrical impulses originating in an endless loop of code-punched tape which contains problems representing all possible uses of the calculator. An inspector scrutinizes the print-out from the machines for signs of malfunctioning.

and at the same time allows maximum standardization of parts during production.

Close attention was given to the paperwork procedure to make it match the manufacturing need for rapid communication of engineering and production information. Engineering drawings, lists and manufacturing instructions have been placed on tape. This required that engineering drawing numbers be made compatible with the requirements of tape and punched cards, and illustrates the extent to which the company went in overhauling its procedures in establishing a modern motor manufacturing facility.

Applied Magnetics Research

EXPANDED research services have been announced by Bussey Research Laboratories. Of interest to manufacturers of data processing, computing and control equipment is the private research work the company has undertaken in the field of applied magnetics. Preliminary work, it is reported, points to a number of innovations that will make possible the elimination of moving parts and mechanisms employed in current product designs. Potential applications which are suggested by the research indicates that it will be feasible to record and produce sound; record and reproduce pictorial and other visual data in magnetic replica; record, store and reproduce information either digital or analog in nature; and select circuits by magnetic methods—all without the use of moving parts typical to mechanical switching and relays.

MEETINGS AND EVENTS

July 29-Aug. 2—

National Machine Tool Builders' Association. Annual joint sales conference with American Tool Distributors' Association to be held Cornell University. Additional information may be obtained from NMTBA offices, 2071 E. 102nd St., Cleveland 6, O.

Aug. 20-23—

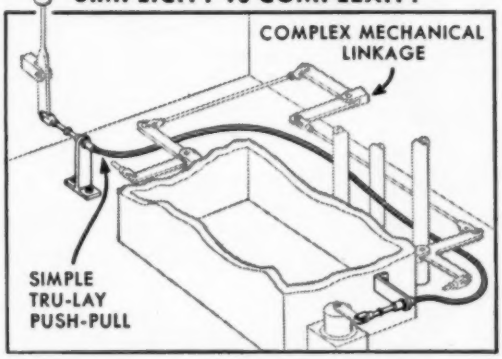
Institute of Radio Engineers. Western Electronic Show and Convention to be held Fairmont Hotel, San Francisco. Additional information may be obtained from Wescon headquarters, 342 N. La Brea, Los Angeles 36, Calif.

Aug. 28-30—

Instrument Society of America. International Symposium on Gas Chromotography to be held Kellogg Center for Continuing Edu-

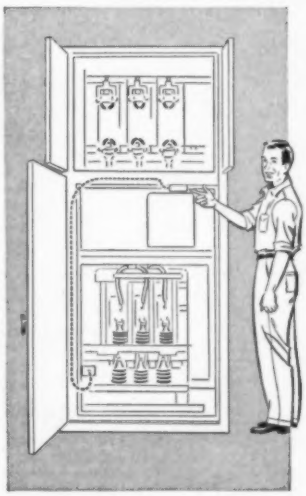
Design Engineers find PUSH-PULL Controls eliminate complicated mechanical linkages

SIMPLICITY vs COMPLEXITY



Compare the TRU-LAY PUSH-PULL cable in the illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts and wear at many points. Their use brings increasing backlash, lost accuracy and vibration.

USED AS A DOOR INTERLOCK IN HIGH-VOLTAGE CABINET



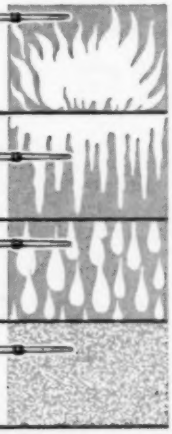
TRU-LAY PUSH-PULL cable insures high-voltage load is OFF before door can be opened.

Saves Space because it is flexible as a wire rope and fits easily into limited space.

Easy to Install with a simple clip where loads are light—clamped at the conduit fittings with a machined bracket.

Economical because it requires no maintenance. We have never known a TRU-LAY PUSH-PULL to wear out in normal use.

VERSATILE TO MEET THE TOUGH JOBS



HOT JOBS — TRU-LAY PUSH-PULLS will function under high temperatures. Are ideal controls for jet aircraft and industrial furnaces.

COLD JOBS — TRU-LAY PUSH-PULLS will function accurately in cold as low as —70°F.

WET JOBS — TRU-LAY PUSH-PULLS are highly water-resistant by virtue of their construction.

ABRASIVE JOBS — TRU-LAY PUSH-PULL cables can be completely rubber-covered for extra protection.

TRU-LAY PUSH-PULLS will handle heavy, tough jobs with up to 1000 lbs. input. They are effective controls for remote jobs 150 feet or more from the control point. They are frequently and successfully used in conjunction with electric, hydraulic and pneumatic controls.

CHECK THESE FEATURES AGAINST YOUR REQUIREMENTS

ADAPTABILITY • Approximately 80% of installations are met by standard anchorages, fittings and heads. Simple modifications meet almost every design requirement.

ACCURACY • TRU-LAY PUSH-PULLS are precision-built products. Accuracy is inherent in the basic design and standards of quality.

TROUBLE-FREE • TRU-LAY PUSH-PULLS are sealed against the entrance of dust, dirt or other foreign matter. The inner working member is lubricated for life.

LONG LIFE • Every feature of TRU-LAY PUSH-PULL construction makes these controls strong, highly resistant to stretch and compression, yet extremely flexible. None has ever worn out in normal service.

The six bulletins and booklets in the **DATA FILE** *will answer many questions on* PUSH-PULLS. *Write for your copy.*

Push-Pull DATA FILE

ACCO

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

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2216 South Garfield Ave., Los Angeles 22 • 929 Connecticut Ave., Bridgeport 2, Conn.

TRADE MARK

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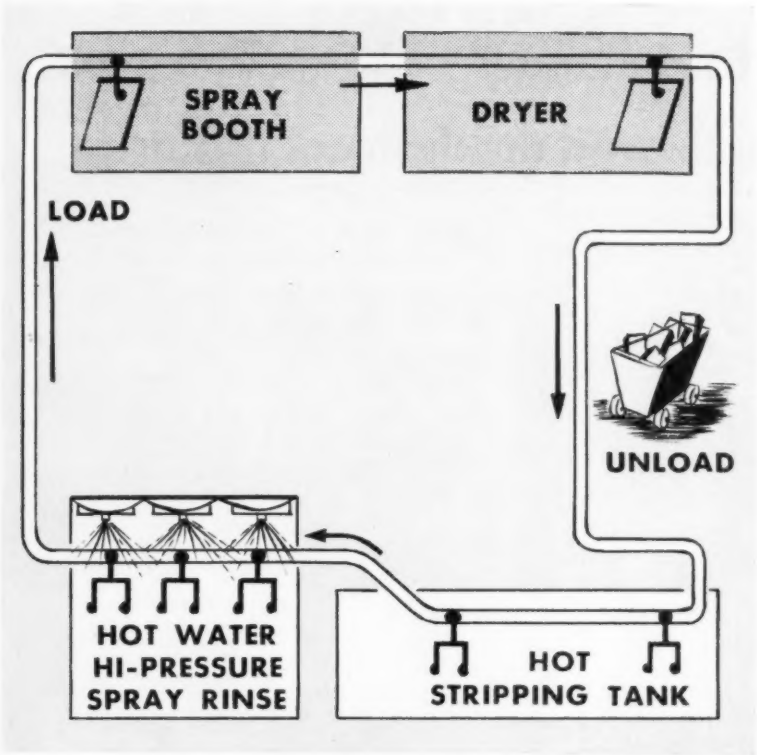

New Modern Method for

CONVEYOR LINE PAINT STRIPPING

With more and more plants incorporating the stripping of hooks, shields, trucks and other paint conveyor-line apparatus into the production line itself, there is an ever increasing need for an automatic stripping method which will work quickly, thoroughly and economically to prevent the build-up of over-spray.

And the answer to that need . . ? It's here, in this . . .

MAGNUS METHOD

Research by Magnus technicians has proven that the simple addition of a quantity of MAGNUS 751 to any of the Magnus Heavy-duty Alkaline Strippers provides unequaled speed and effectiveness. Even the difficult-to-remove types of paints and primers are effectively and thoroughly stripped. And, this method is highly economical, since the MAGNUS #751, in addition to increasing the effectiveness of the strippers, also extends the already-long life of the solution.

For full information on this modern production-line method, including detailed recommendations and methods for determining correct proportions, write today to Magnus, 101A South Avenue, Garwood, New Jersey.

magnus

Industrial Cleaning Division

MAGNUS CHEMICAL CO., INC.

—a world-wide organization specializing in cleaning and protection of all surfaces.

cation, E. Lansing, Mich. Additional information may be obtained from H. J. Noebels, General Chairman, IGC Symposium, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Sept. 9-13—

Instrument Society of America. Twelfth Annual Instrument-Automation Conference and Exhibit to be held Cleveland Auditorium, Cleveland. Additional information may be obtained from H. S. Kindler, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Sept. 17-18—

Radio - Electronics - Television Manufacturers Association. Symposium on Numerical Control Systems for Machine Tools to be held Ambassador Hotel, Los Angeles. Additional information may be obtained from RETMA, Room 650, 11 W. 42nd St., New York 36, N.Y.

Sept. 23-25—

American Society of Mechanical Engineers. Fall meeting to be held Statler Hotel, Hartford, Conn. Additional information may be obtained from ASME headquarters, 29 W. 39th St., New York 18, N.Y.

Sept. 24-26—

Sixth Annual Industrial Electronics Symposium. Co-sponsored by IRE and AIEE, to be held Morrison Hotel, Chicago. Additional information may be obtained from AIEE headquarters, 33 W. 39th St., New York 18, N.Y.

Oct. 7-9—

Second Conference on Manufacturing Automation. Co-sponsored by Purdue University and AUTOMATION Magazine to be held Purdue University. Additional information may be obtained from the Editor, AUTOMATION, Penton Bldg., Cleveland 13, O.

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kdi Hoppervator®

COMBINES: Bulk parts storage • Floor level loading
Part orientation • High-rate positive delivery
INTO A SINGLE LOW COST VERSATILE FEEDER

FEEDS: Bearing Races • Oil Seals
Sheared Slugs • Bolt Blanks
Semi-finished Parts

AVAILABLE: in light and heavy-duty units in a wide range of standard capacities and heights

kdi KDI CORPORATION
950 EXCHANGE STREET • ROCHESTER 8, N.Y.

SPECIALISTS IN MECHANICAL HOPPERING, AUTOMATIC ASSEMBLY MACHINES, AND INTEGRATED PARTS PRODUCTION LINES

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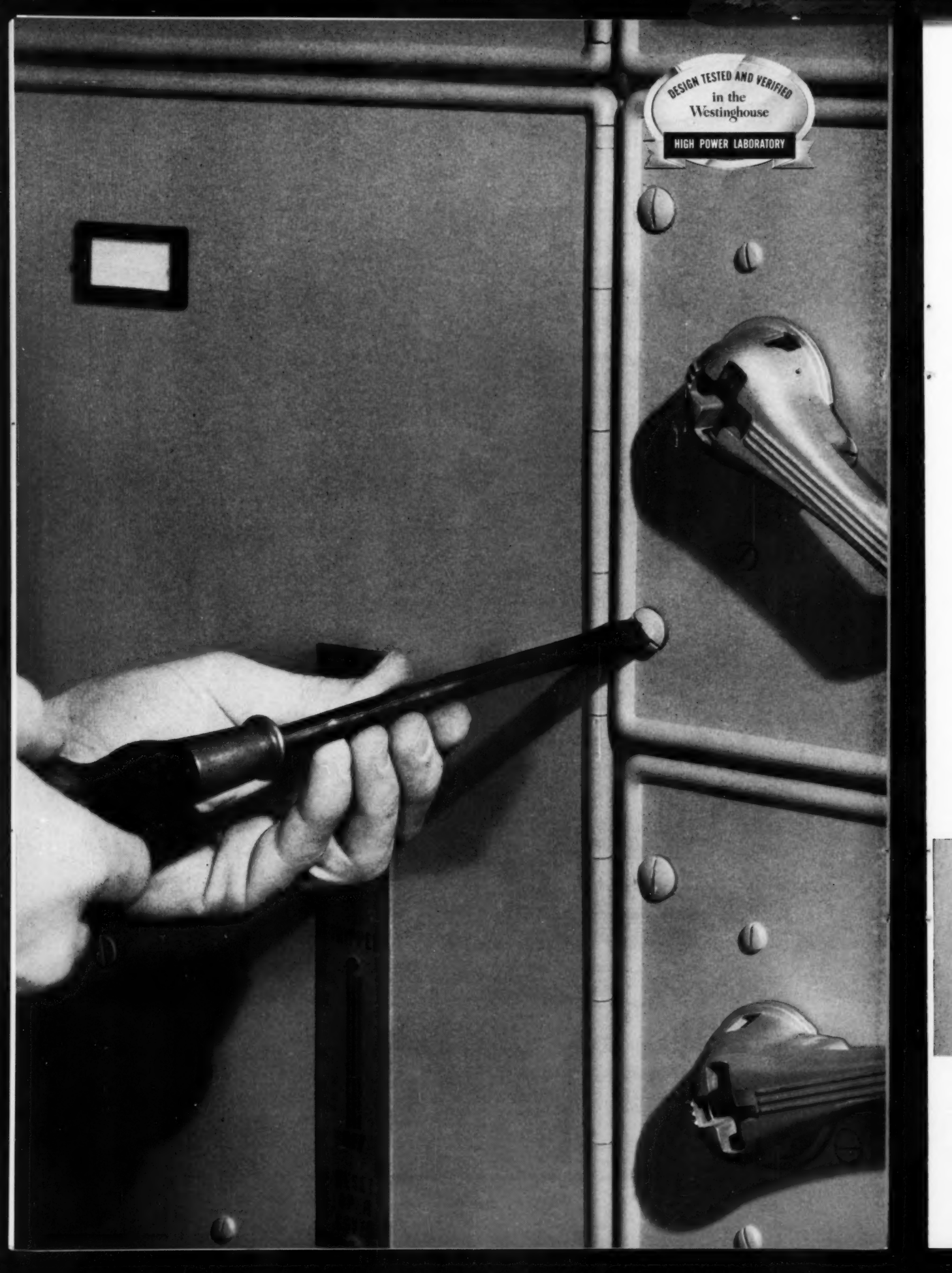

DESIGN TESTED AND VERIFIED
in the
Westinghouse
HIGH POWER LABORATORY

Now Westinghouse announces complete control center flexibility

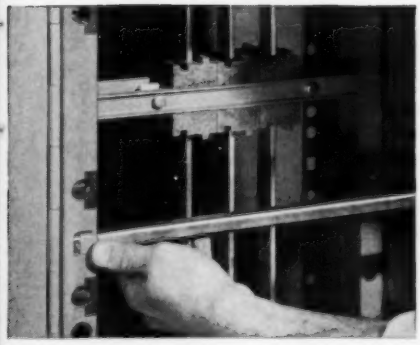
New design meets changing requirements with both 14- and 9⅓-inch modular units

From the new 9⅓-inch units to the dependable electrical components, the new Westinghouse control center is designed to meet your present requirements and future needs. Both the 14-inch and 9⅓-inch units can be quickly interchanged within a standard structure.

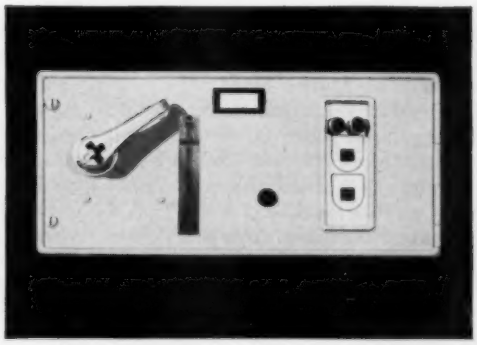
Fully interchangeable with the old design, this new control center is available for front mounting or back-to-back mounting . . . in same structure with common vertical bus. Everything about this new Westinghouse unit says good design, safety, and versatility. And you have the advantage of dealing with one source to supply all components. Call your Westinghouse sales engineer for all the facts. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. Ask for B-6722. J-21941

YOU CAN BE SURE...IF IT'S

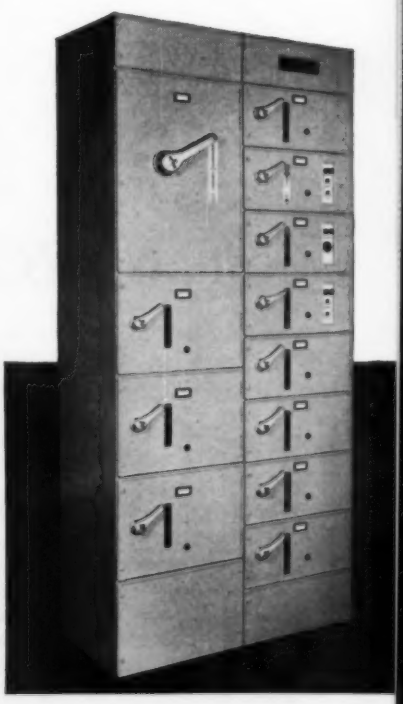
Westinghouse



Slight Movement of Retaining Clips . . . and horizontal starter unit support bar can be moved to any position for interchangeability of 9⅓- or 14-inch Westinghouse modular units.



Door Cutout makes it unnecessary to change door when changing pilot device arrangement. Quick-make, quick-break, positive-action, modern pushbuttons in strong molded case take up less space.



Here Is Complete Flexibility . . . of structural units and electrical components. Each vertical structure holds from one to eight, front only, or up to 16 back-to-back units, to meet all needs.

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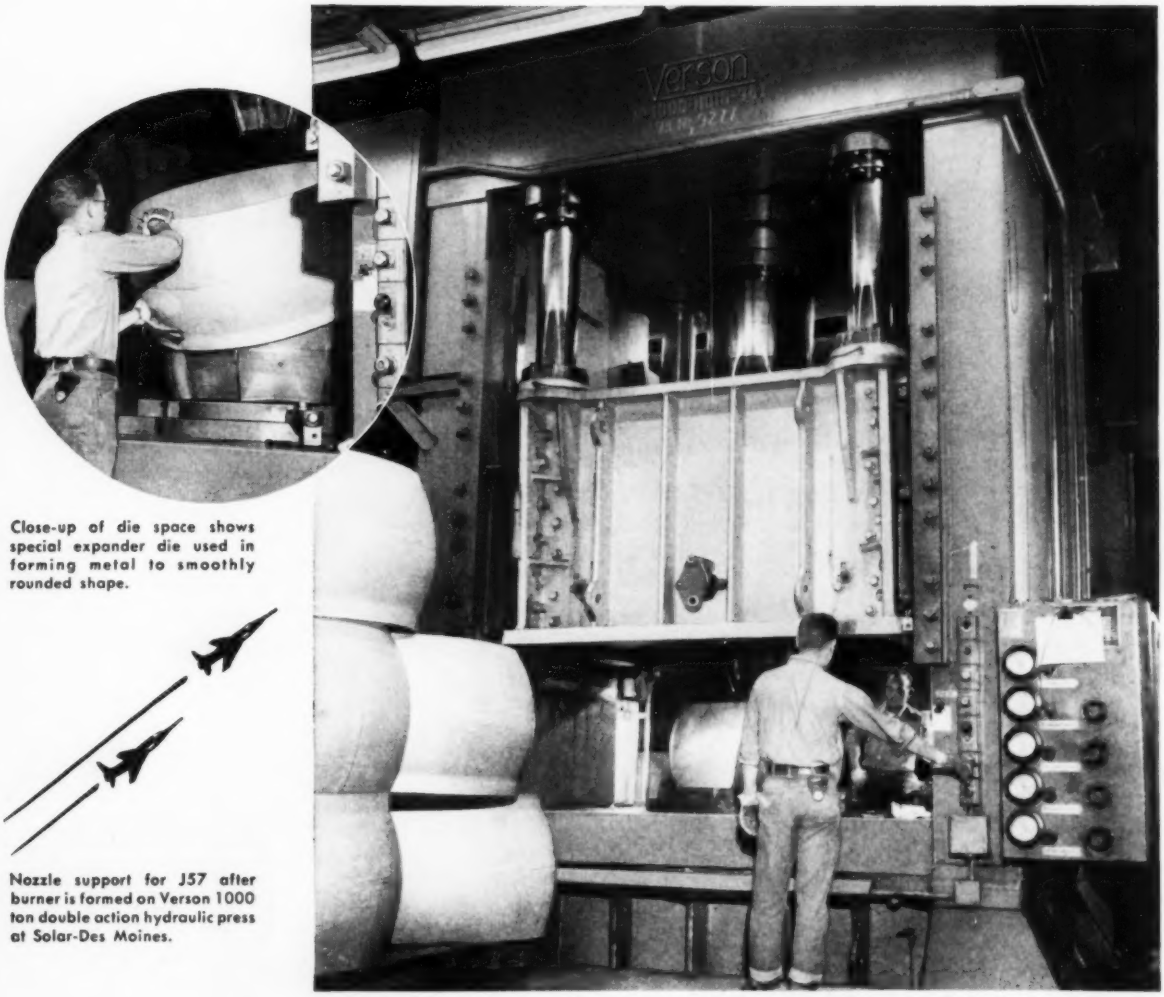

Close-up of die space shows special expander die used in forming metal to smoothly rounded shape.

Nozzle support for J57 after burner is formed on Verson 1000 ton double action hydraulic press at Solar-Des Moines.

Another TRADE Verson MARK Press proves its versatility

. . . forming jet engine components at Solar Aircraft Company

This is Verson versatility at work . . . a 1000 ton Verson double action hydraulic press . . . "workhorse" at Solar Aircraft Company's Des Moines plant.

Solar produces components for jet and turbo-jet engines which power a number of our best known aircraft. They are also engaged in the manufacture of components for guided missiles. To this end, a variety of tasks are assigned to this Verson Press, including heavy duty expanding, sheet metal embossing and deep drawing. Forming is done primarily with 300 series or 410 stainless steels, ranging in thickness from .031 to .093.

The double action press, largest of its type at Solar-Des Moines, has proved a rugged and versatile production tool. In addition to the heavy jobs, it handles general production when needed.

Big job . . . small job . . . there's a Verson press for you. For specific recommendations send an outline of your requirements.

A Verson Press for every job from 60 tons up.

TRADE Verson MARK

ORIGINATORS AND PIONEERS OF ALLSTEEL STAMPING PRESS CONSTRUCTION

VERSON ALLSTEEL PRESS CO.

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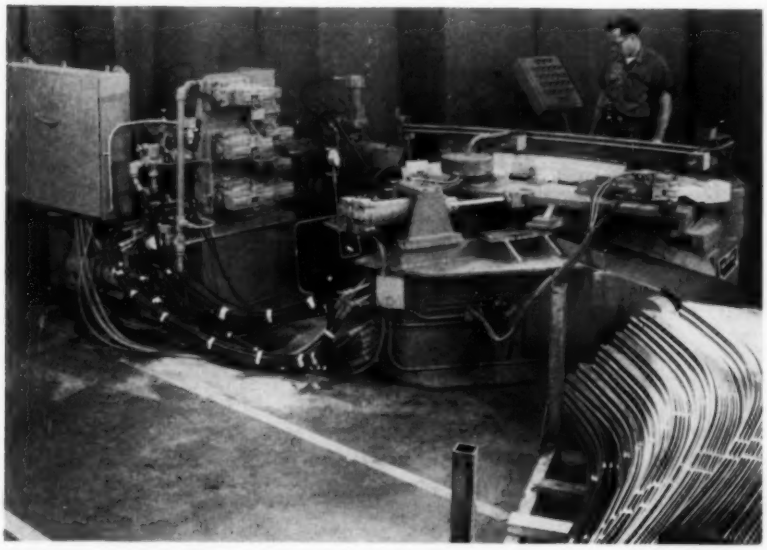
MECHANICAL AND HYDRAULIC PRESSES AND PRESS BRAKES • TRANSMAT PRESSES • TOOLING • DIE CUSHIONS • VERSON-WHEELON HYDRAULIC PRESSES

By JAMES C. KEEBLER
Associate Editor



Chrysler engineers devised a drain trough molding that is a structural part of the automobile roof and developed an automated process for the high-speed manufacture of this complex shape. Pictured is a radial draw former built by Cyril Bath Co. to stretch these parts into the final contour and cross-section

Never Say Never

ARDENT STUDENTS of the science and art of automation are constantly reminding us of the necessity of close co-operation between product designers and processing engineers. To accomplish the optimum yield from efforts to automate, these two forces must be pulling together.

The more zealous proponents of this happy harmony recommend that these forces be combined into one and that product designers learn all the tricks of the processing engineer's trade. This circumstance may be ideal in the small enterprise where one man can juggle both functions at once and keep them both in the air. In the auto industry where the complexities require big crews pulling at each function the feasibility of combining product design and process engineering is a matter of serious doubt.

Cozy Compromise

Though complete combination may be out of the question, efforts to co-ordinate are certainly steering the automotive enterprise in the right direction. The classic attitude barriers: ". . . success at last it can't even be cast" and ". . . you guys couldn't even cast window weights" must be torn down. Product designers and processing engineers must learn enough about each others problems to assist in accomplishing the corporate objectives.

The cozy compromise system has much to recommend. By this plan of attack each team does its preliminary work independently; then they get together for study, and subsequently finalize their prints on the basis of joint opinion. If this technique is to get off the ground each party must have an open mind to change. They must never say never.

Benefits of close co-ordination between product designers and processing engineers can be seen in Chrysler's manufacture of drain trough moldings for 1957 cars.

From the product designer's point of view, a drain molding is needed along the sides of the roof just above the doors and at first thought it matters little how it's made. But when one stops to consider that hardtop convertible designs need additional strength in their roof supporting members a change in the design detail to make the drain trough molding a structural member has real appeal.

Such a part can be made by radial draw forming but the process was spawned in the aircraft and heavy transportation industries, and not generally considered a high-production technique suitable for automobile parts manufacture.

Open the Mind

Results of an open-minded approach are coming off automated radial draw forming machines at Chrysler's Eight Mile Road Plant. John E. Brennan, vice president, Stamping and General Manufacturing Group, says: "These radial draw forming machines operate at high speed to produce 300 to 400 pieces per hour—an increase of 200 per cent over previous methods of making drain trough moldings."

In operation, the part is automatically fed into the machine where the ends are held in gripper heads connected to hydraulic stretch cylinders. A pull of about six tons is exerted to stretch the part so that the metal softens and flows. Two die elements are then rocked into each other under 4½-ton pressure—forming the piece a bit at a time. The formed part is then automatically unloaded and the cycle starts again.

These complicated pieces cannot be practically made with simple bending machines or in conventional stamping presses where the operations would be expensive and inaccurate. "With the trend towards fewer roof supports in all

types of cars, the increased strength obtained by stretch forming—in which the granular structure of metal is elongated and ironed together into a new shape—is a distinct advantage," Brennan said. People know a good thing when they see it. Characteristically, Cyril Bath Co. announced that they would also supply machines for producing door pillars, quarter panel pillars, corner strainers, trunk drain troughs and such other curved shapes as the engineers may determine.

Application of the techniques of automation to a process whose fullest advantage is utilized by a product design revision has produced improvements that should teach even the most rut-bound process engineer not to say: "It can't be done."

Piano Roll Blues

With this thought in mind it is well that the automakers not take too hasty a look at the developments in the art of tape or card programed machines.

Just because a bulk of this development is taking place in the aircraft industry where production quantities are of a different order of magnitude is no reason to conclude that there is nothing in it for the auto industry.

Bendix Aviation's Murray Kanes whose hand was in the design of the control system for the 4 by 10 foot, Kearney and Trecker horizontal spindle, contour milling machine for Glenn L. Martin says: "The immediate application of tape control in the automotive industry appears to be in the making of tools and dies rather than parts. The prospect of reducing the high cost and long lead time involved in the many automotive body and forging dies which are required indicates extensive applications for tape controlled die sinking machines."

This is good. When the piano roll gets its foot in the automotive door other ideas may unreel.

At an ASTE—Case Institute discussion of machine programing, Bill Gillet of Parker Appliance asked the panel if they were going to adapt these numerical control systems to high production machines in such a manner that one console would operate a multiple number of machines and all you would have to do to get more production would be to plug in more machining units. No one present had such a system, but they answered a question by Bob Young of Thompson Products that the same tape would produce identical parts on identical tape controlled machines.

In one way or another processing engineers are going to find a way to get more out of these developments than just toolroom duty.

Flexible Equipment

Ford's Harder told the National Machine Tool Builders' Association of his desire to have greater flexibility of design of machine tools. After outlining his points of dissatisfaction with standard machine tools linked together, and with the inflexibility of large transfer machines he went further to state his case for building block units built to an industry standard.

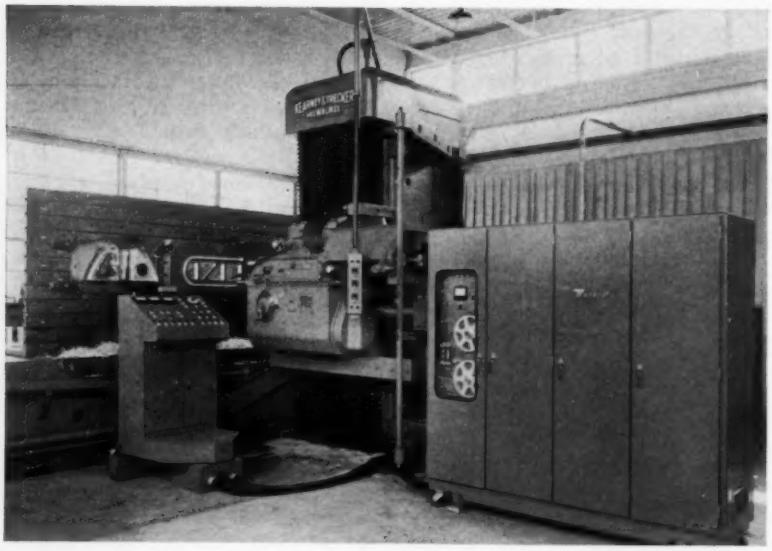
Harder said "Rather, we at Ford hope that standardization of dimensions of machine tool units to attain interchangeability and freedom of rearrangement will be brought about by voluntary co-operation of builder and user groups. The automobile companies certainly do not want frozen designs.

"Unitized machine tools built up of standard components would be easier to set up. Each station would be a machine in itself—complete with its own electrical and hydraulic circuits. Hence, any given station could be cycled for set-up purposes. More stations on an in-line machine could be set up simultaneously, thus reducing the time required to get into full production."

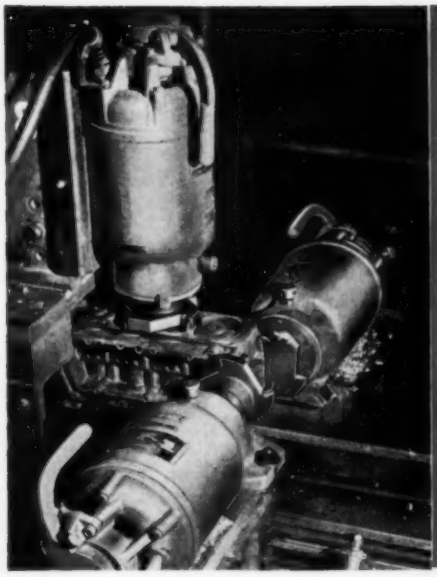
In the Cards

A combination of this concept with that of units plugged into a master programer is not such a far stretch of the imagination. The flexibility the automaker wants may be in the cards—or the tape.

IBM chose a Fosdick jig borer to be card programed because it had characteristics suitable for operation from electrical pulses. Vickers' Ron Render told the Vickers' Fabricating Machinery Hydraulic Conference of the potentials of applying electro-hydraulic servo valves to production equipment. Put these two nuggets together and never say never, and we find the potential tools being developed for the processing engineer's use are a challenge to the imagination.



Tape controlled Kearney and Trecker milling machine to be used by the Glenn L. Martin Co. has electronic control system that was designed and built by Bendix Aviation Corp. Operator's console includes feed rate override control and precision positioning control for manual setup. Manual feed controls are located on the pendant.



MILL UP TO 3 SIDES AT ONE TIME
WITH
Onsrud
A-242S
TRI-WAY MILLING MACHINE
a member of the COMPLETE family of Onsrud Milling Machines
designed specifically for Aluminum and related nonferrous milling

PROOF of the tremendous productivity of Onsrud milling machines designed for nonferrous milling is shown by this production study. This kind of production is typical of the advantages that can be yours with every Onsrud milling machine.

THE PART: Outboard motor cylinder block, aluminum alloy casting 7" wide x 13" long and 6" high.

THE MACHINE: Onsrud A-242S Tri-Way Milling Machine with one vertical and two horizontal opposed milling heads.

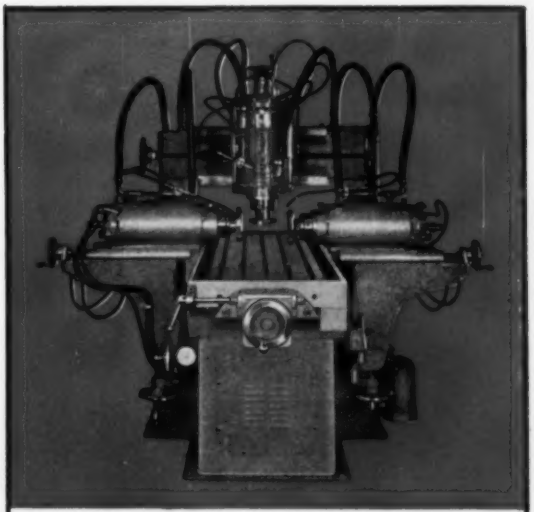
OPERATION: Machine three sides of block in on set-up and in one pass.

ACCURACY: Flatness tolerance ± 0.0003". Parallel tolerance ± 0.001".

PRODUCTION: Three parts per minute.

CUTTER LIFE: 500 to 1,000 parts per regrind.

Onsrud high speed milling production is only possible because Onsrud machines are designed and built specifically for milling aluminum and related nonferrous metals. The cutter speeds and feeds are exactly right to give smooth finish and precision . . . at super-high production speeds.



Onsrud A-242S Tri-Way Milling Machine, for milling up to three sides at one time, of any part square or rectangular in cross section. Planer type table with variable feed up to 258 IPM. Cutter motors Onsrud 10 HP, 3,600 RPM, liquid cooled.

Write for Information

Let us give you complete data on the Onsrud A-242S Tri-Way Milling Machine...and all other Onsrud milling machines for nonferrous metal milling. Get the facts on these proved, high speed production machines. Your inquiry is cordially invited.

ONSRUD
MACHINE WORKS, INC.
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Onsrud® HIGH SPEED **MILLING MACHINES** FOR ALUMINUM AND RELATED NONFERROUS METAL MILLING

for doing things better by doing things differently!

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AUTOMOTIVE AUTOMATION . . .

These two different examples of automatic high production machines demonstrate the imaginative engineering which has earned for Hartford Special such a fine reputation among automotive manufacturers.

But Hartford Special automated equipment is not limited to large plants. The same standard machine components which we use in our own complete machines are available to you as separate elements for assembly into complete machines on your floor. The components include quill type drilling units, lead screw tapping units, power operated index tables, columns and machine bases. Thus the benefit of automated equipment can be had by small plants or by shops faced with diversified mass production.

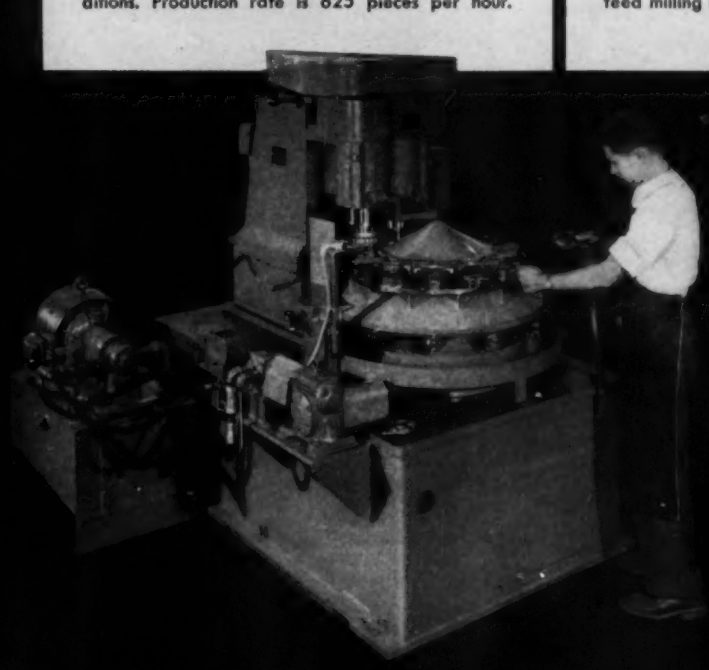
Whichever way you need automation — complete machines or "building block" components — Hartford Special is your most efficient and economical choice.

CONTINUOUS MILLING MACHINE

mills the top and bottom pad of generator end castings. Work is automatically and continuously fed between revolving cutters of variable speed milling heads. Speed of rotation of power table and milling heads can be regulated to suit conditions. Production rate is 625 pieces per hour.

FIVE STATION AUTOMATIC INDEX MACHINE

performs multiple operations on automotive power steering gear box simultaneously. Machining includes angular milling, drilling, reaming, spherical seating and facing. This machine features hydraulic power clamping, automatic lubrication and variable feed milling head.



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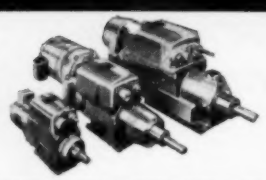

AUTOMATIC AIR-HYDRAULIC DRILL UNITS

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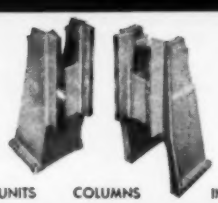

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INDEX TABLE SUPPORT

PEDESTALS

MACHINE TOOL DIVISION
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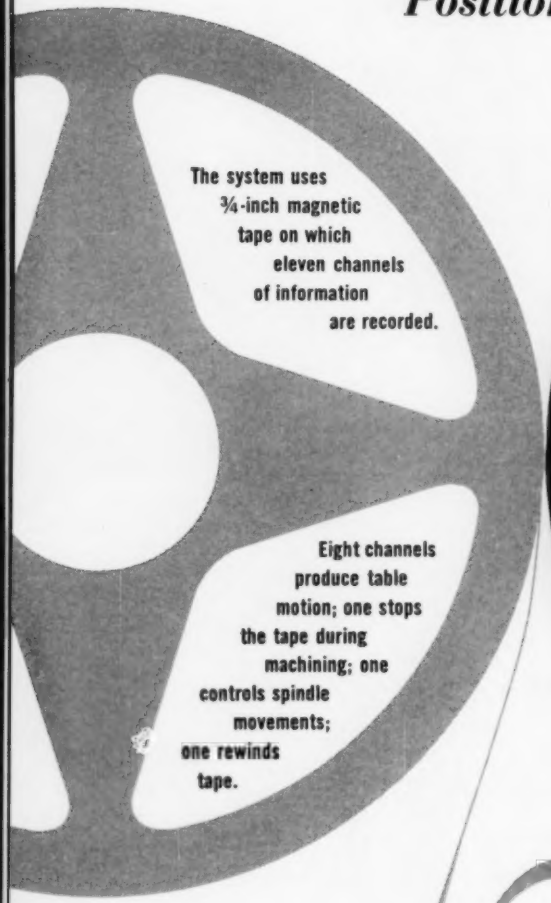
The New Allison FULLY AUTOMATIC

Positioning Table


The system uses ¾-inch magnetic tape on which eleven channels of information are recorded.
Eight channels produce table motion; one stops the tape during machining; one controls spindle movements; one rewinds tape.

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Range of motion	20" x 10"
Speeds, infin. var.	0" to 50" per min.
Accuracy	± .001"
Table thrust, max.	1000 lb.
Table dimensions	50" x 35" x 15" high
Console dimensions	22" x 19½" x 48" high

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Another step toward complete automation of machine tools is provided with the Allison table. It has been developed to fill the need for a portable, precision machine of simple operation requiring no special operator training, and so inexpensive as to be a practical investment for all manufacturers, large and small. By eliminating the human element, quality is improved because of increased accuracy and uniformity. Rejects are minimized. More parts are completed in the same time. Because table motion and speed are continuously controlled, milling can be done. This system has been successfully applied to an engine lathe. Our Engineering Department will gladly work with you on your specific requirements.

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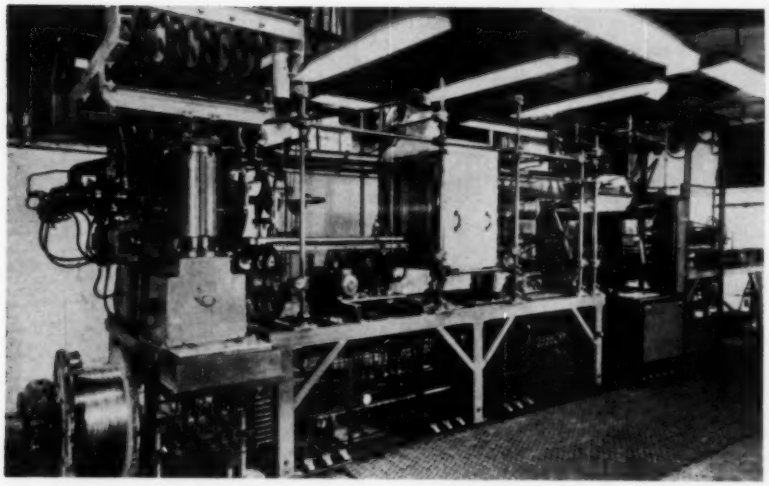
notes from britain

By FRANK G. WOOLLARD
British Correspondent



Continuous process bicycle tire bead machine makes 3,000 beads an hour. Wire goes into the machine from reels at the left, is formed to circular shape, cut, ends threaded, a sleeve applied, then hammered into a tight bond and stacked, all automatically. Key to success of the machine is a rotary swager developed by National-Standard Co., Ltd., to bond sleeves to the wire.

Inspection and Maintenance

GIVING advice on the essential features of automation, in one of the American journals, one authority suggested, among other items, the correction of processing as soon as parts begin to drift from the set standard of quality. America does not differ so greatly from Britain in this respect; namely that it is so difficult to detect the very gradual falling away from standard which eventually spells trouble. The trouble when it occurs becomes very conspicuous in an automated factory where the downtime for corrections on a faulty machine will, almost certainly, entail the stoppage of the complete machine line and, more often than not, the assembly line also.

This situation was not so highly visible in the more elementary production layouts, e.g. batch production, but nevertheless it existed to promote inefficiency and loss. This was so, even though the work could be transferred to another machine or even if the lost time could be regained by working overtime.

Now obviously the remedies against these departures from standard consist of vigilant inspection and preventive maintenance.

Let us first consider preventive maintenance. Does this really cover the whole situation—is it by itself good enough? In effect, preventive maintenance resolves into routine attention. The routine schedule when based on actual experience is excellent but . . . are there no loopholes? Is it not true that on occasions more wear takes place than was anticipated? Is it not true that something slips sometime or other—that a screw, a nut or key loosens? Is it not a fact that lubrication may fail and that slides may stick or that, for some unknown reason, guide bushes wear unduly? All things are possible and may be the cause of trouble, slight enough in the beginning but cumulative in effect.

Liasion Needed

Now let us turn to inspection. It is true that manual gauging and visual inspection is giving place to mechanical, pneumatic and electronic inspection devices. Even so it remains essential to cope with the causes for any degeneration from standard; the method being the keeping of a close watch on the permissible tolerances and anticipating the need for corrective action. The question arises as to whether a liaison can be established between the functions of inspection and maintenance which will make fully effective the principle that *maintenance must be by anticipation—never by default.* If this can be done, preventive maintenance will become an active process instead of a routine operation. It will become "preventive" in the full sense of the word.

Redefined Responsiblity

The writer suggests that the logical answer to this question lies in the extension of the duties of the chief inspector or the quality control manager—or whatever designation is current for the officer responsible for seeing that the piece parts are correct to specification.

Already this official is responsible for purchased materials, bought in finished parts, and also fixtures, jigs, tools and gauges, whether these are made by the company or bought from outside. It is only one step to make him responsible for the inspection of all fixtures, jigs and tools in use. It is but another short step to increase that responsibility to cover the inspection of machine tools. In effect this would mean that when there is a departure from standard the inspection func-

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tion would not merely reject and report on the matter but would ascertain where the faults originate: whether in cutting tools, in gauges, in fixtures or in jigs or jig bushings or, in fact, in wear or maladjustment of the actual machine tool. If this were done, the inspection department would be elevated from its present somewhat negative or "thou-shalt-not" function to become an active participant in the productive process.

It is conceivable that such a liaison will become more necessary and more effective as automatic inspection takes over more of the tasks that have previously been undertaken by human examiners because such devices will accept or reject but will not qualify their findings.

Functional Considerations

Obviously this extension of the duties of the inspectorate calls into question the status enjoyed by the officer in control of the inspection function. It is axiomatic that he should not be responsible to any interested party who can influence or overrule his decisions in regard to what is acceptable for inclusion in the finished product. In this role as umpire the inspector is the customer's representative and it is on his judgement that the popularity of the product and the goodwill of the customer depends.

However, when a decision has to be made which involves a change of equipment or the stoppage of a machine and possibly replacements or repairs, the circumstances are different. Other executive and functional offices are involved so that there must be a properly recognised formal method of dealing with the production, repair and maintenance executives. This, however, is one of the matters with which those who frame the structure of the organization can readily deal and it should not adversely affect any decision to adopt this proposed new liaison, which should be the means of gaining more immediate control over the maintenance of essential standards of quality.

Here and There

● In Britain there is a growing tendency for the larger industrial concerns to establish training centers for their staffs. The usual procedure is to take over a large country house and to adapt it to the requirements of residence and lecture theatres. There is, owing to the very high taxation in this country, no shortage of suitable houses. The courses may involve one night's residence or they may last for fourteen days.

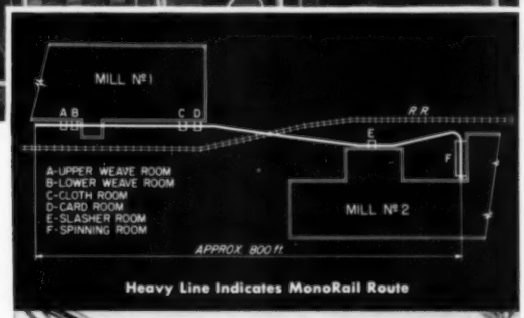
These "staff colleges" do not compete with the technical colleges except perhaps to draw upon them for personnel. Two such appointments have recently been made. The College of Technology, Birmingham—which has been designated as an Advanced College—recently lost James Wilson, the principal, to the British Motor Corp.

Also the principal of the Wolverhampton and Stafford College of Technology, C. L. Old, will shortly become adviser on education and training to the great Vickers combine. In addition to staff training Mr. Old will have 5,000 apprentices under his guidance.

Yet another principal, F. W. Cooper, of the Chance Technical College at Smethwick, is joining the Institution of Production Engineers as education officer. Younger lecturers have frequently been recruited as training officers in the past but this is exceptional inasmuch as three top-ranking educationists have been drawn from a small area in the Midlands within the past half-year.

● National-Standard Co., Ltd., British subsidiary of National-Standard Company, Niles, Mich., has developed a machine for joining two ends of wire together in a bond of exceptional strength. It is used in the manufacture of high-pressure bicycle tire beads.

The swaging machine is part of a fully automatic manufacturing line in the new Kidderminster plant of National-Standard Co., Ltd., producing 3,000 bicycle tire beads an hour. It is expected to speed up a critical operation in tire manufacture and produce strengthening beads of higher quality, according to John T. D. Spence, managing director, who is co-inventor of the device.



Heavy Line Indicates MonoRail Route

AMERICAN MONORAIL

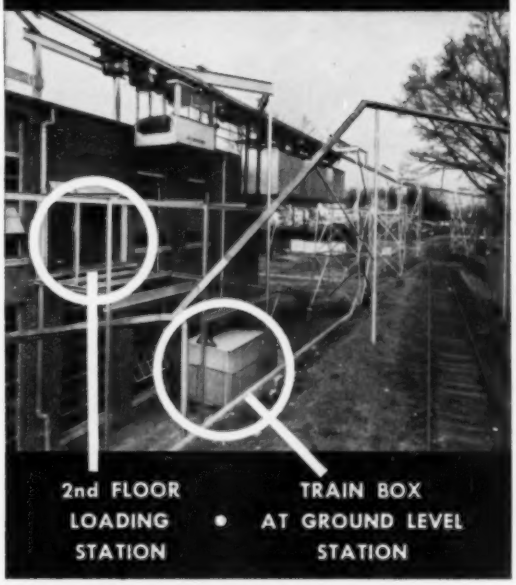
transports cars between 2 mills-

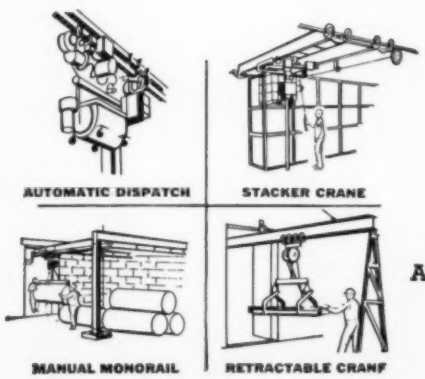
stops at ground and upper level stations.

The equivalent of several elevator loads of material can be transported from building to building and from floor to floor by this modern materials handling system. Erected entirely out of doors, the MonoRail operates overhead, safely above railroad and all other traffic, and takes up no space at all inside the mills.

Loads transported consist of warp beams, boxes of filling quills, roving, trucks of drawing sliver and cloth. Approximately 132,000 lbs. from stations at each mill are transported during an 8-hour shift.

All operations can be controlled from the cab which is equipped with heaters, electric fans, windshield wipers, a gong and spotlights for night operation.





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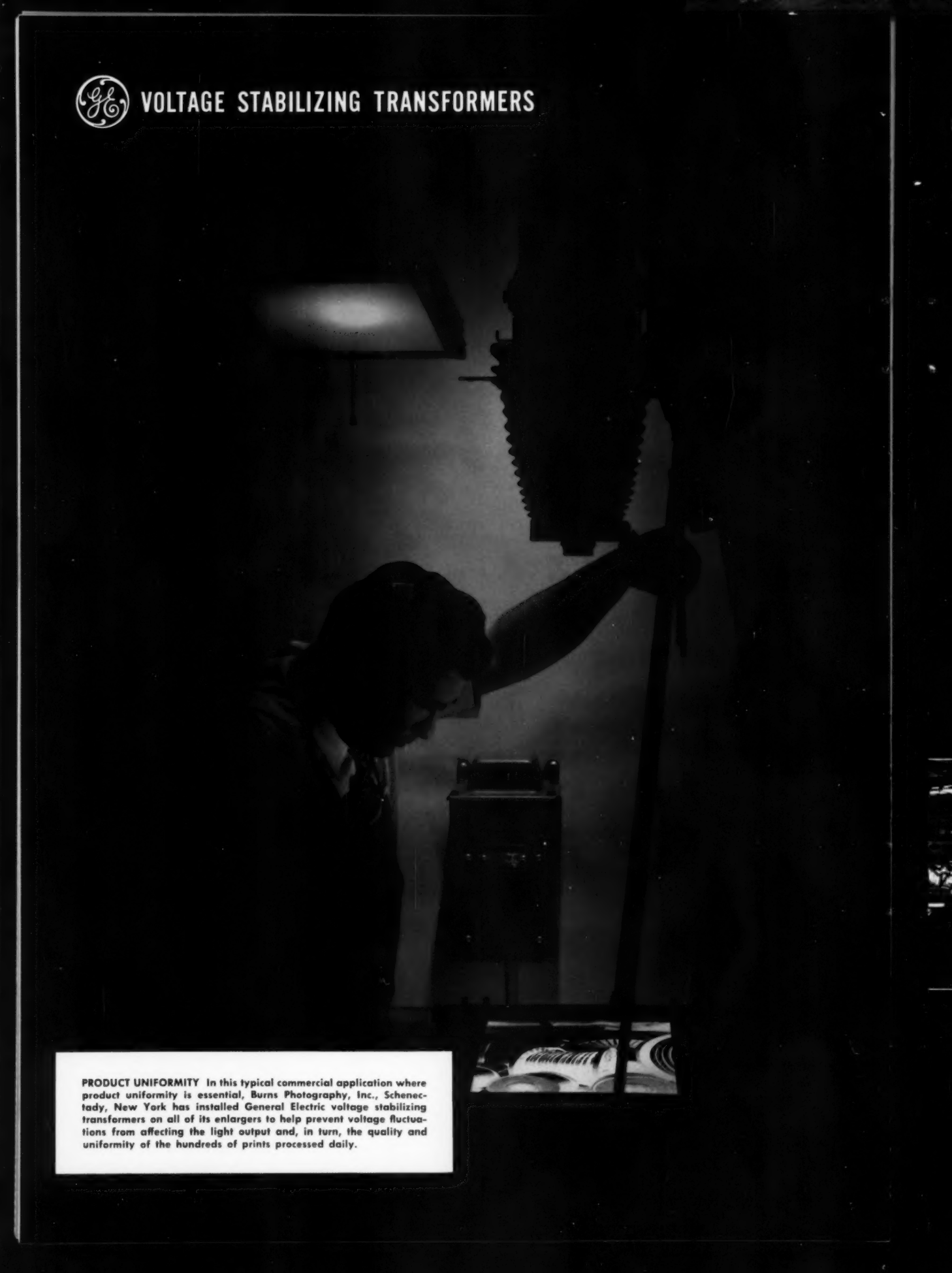
VOLTAGE STABILIZING TRANSFORMERS



PRODUCT UNIFORMITY In this typical commercial application where product uniformity is essential, Burns Photography, Inc., Schenectady, New York has installed General Electric voltage stabilizing transformers on all of its enlargers to help prevent voltage fluctuations from affecting the light output and, in turn, the quality and uniformity of the hundreds of prints processed daily.

Here's why General Electric voltage stabilizing transformers help assure . . .

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- **PRODUCT DEPENDABILITY**
- **PRODUCTION CYCLE CONTINUITY**

General Electric voltage stabilizing transformers are factory adjusted to stabilize output voltage to within ±1% in less than two cycles. Even if line voltage fluctuates by as much as 75%, the rapid response of these G-E units helps prevent voltage fluctuations from even momentarily affecting the performance of most equipment. Further, G-E voltage stabilizing transformers are completely automatic – no adjustments are needed; no moving parts, relays, or tubes are present to cause maintenance problems.

These are just a few of the reasons why you can rely on G-E voltage stabilizing transformers to help prevent voltage fluctuations from affecting your product uniformity, end product dependability, or production cycle continuity.

If rejections due to voltage fluctuations are causing you to lose money and man-hours, G-E voltage stabilizing transformers provide the most economical way to correct such losses in most commercial and industrial applications. If the performance of your products depends on stable voltage, G-E voltage stabilizing transformers are components you can't afford to leave out of your product design. And if production cycle continuity means dollars to you, G-E voltage stabilizing transformers in your plant will help prevent momentary voltage surges from shutting down production lines and damaging equipment.

For more information and other reasons why General Electric voltage stabilizing transformers will help keep your costs down and production up, contact your nearest General Electric Apparatus Sales Office or distributor today. Or, write for bulletin GEA-5754 to Section 410-43, General Electric Company, Schenectady 5, New York.

PRODUCTION CYCLE CONTINUITY In the Ford Motor Company's new Mahwah, N. J. assembly plant, G-E voltage stabilizing transformers are used to stabilize control voltage on over 11 miles of assembly lines. More than 60 G-E units help keep production flowing during line surges caused by electrical storms.

PRODUCT DEPENDABILITY Electronic Research Associates, Inc., Nutley, N. J. uses G-E voltage stabilizing transformers exclusively on its line of tubeless transistor equipment. Reliable service evidenced by no field failures in over five years and space saving design are two main reasons why these G-E units are used.

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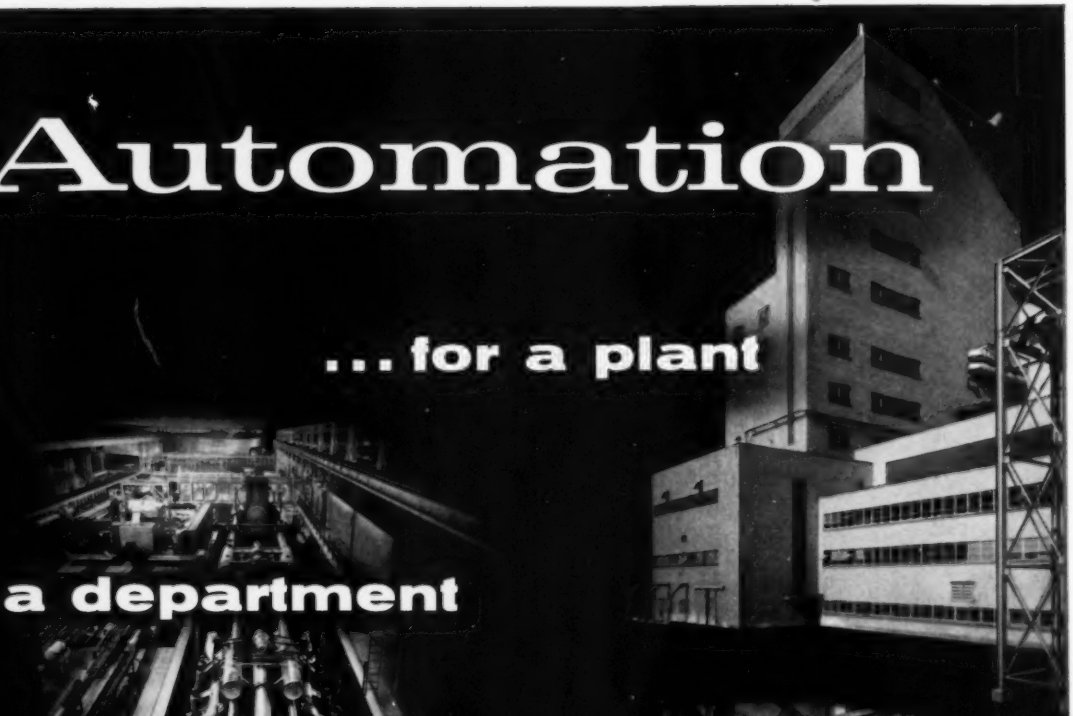

a department

an operation

Frequently, the design of a single machine, or piece of equipment will do the job.

Whether a business is big or small, the correct application of automated equipment will increase output . . . improve product quality . . . and lower unit costs. And it can be done on a practical, cost-recovery basis! Determining whether you need automation or mechanization, *and how much or how little*, is a job that requires seasoned professional engineering experience with its attendant insights into production problems common to many industries.

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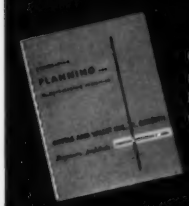

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There are still those today who comment knowingly that their company "is not ready for full automation." Concentrating on definitions, misleading in most instances, executives all too often consider automation a "thing," something available to be readily bought.

Nothing is further from the truth. Automation properly identified, is more a philosophy or a way of manufacturing engineering. It encompasses integration and automaticity of operations, but is guided and stimulated by basic business economics. It is a way of thinking about industrial operations that is process-oriented compared to the product-oriented view of conventional methods.

Whether the manufacturing operation concerns hardware, bread, chemicals, or information, the fundamental, realistic automation philosophy offers results today equally as great as those provided years ago before the word was coined to give the idea substance. Automation of lamp bulb manufacture began in 1919. It is still in process of development. Possibly it will never reach a state of full automation. Newer products will replace the conventional bulb but the lessons learned will create the solid foundations on which a higher state of development can be based.

The possibilities of automation should not be dismissed with definitions. Enlightened investigation from an unbiased standpoint can reveal tremendous opportunities—many unsuspected and others unexpected—that oftentimes involve only moderate expenditures in terms of equipment.

Looking objectively at the problem, Malcolm P. Ferguson, president, Bendix Aviation Corp., in a recent talk called it "productivity and progress." From this practical standpoint anyone can benefit.

EDITOR

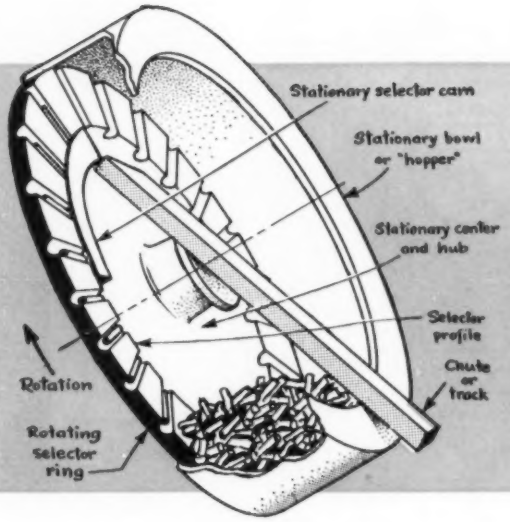


Fig. 1—Rotary ring type of parts selector, probably the most common type in use. A mass of parts to be fed is contained in the stationary bowl. Individual parts are selected from the mass and fed out the chute or track by a rotating selector ring with the aid of a stationary cam. Sketches indicate *(a)* General construction of a rotary ring selector, *(b)* application for feeding headed parts stem first, *(c)* feeding of headed parts hanging from heads, or head down by twisting track 180 degrees, *(d)* feeding of balls, and *(e)* sorting of coins into three denominations. Other items such as bushings, eyelets, irregular stampings, turned parts and irregular machined parts can also be fed and oriented with the ring selector.

MACHINE FEEDERS—1

APPLYING PARTS

ROTARY RING • ROTARY DISK • ROTARY DRUM

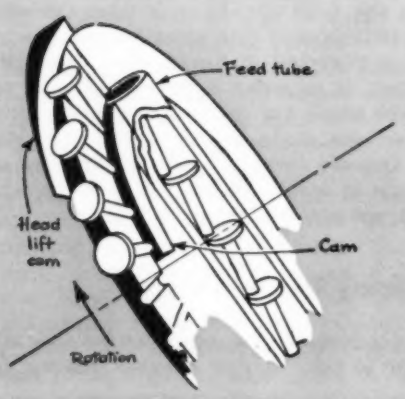
By **KENNETH R. TREER,** Gray Equipment Co., Cleveland, Ohio

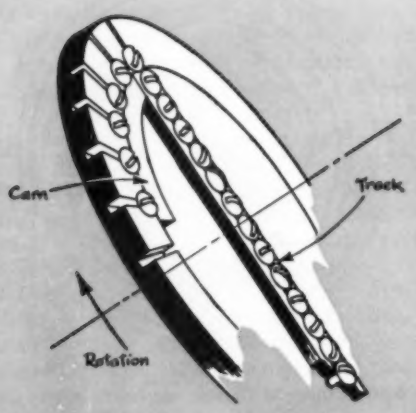
PARTS SELECTORS are devices which hold a quantity of parts, perform one or more orientations or selections of position and discharge them to tracks for use in machines of all types. Many factors determine the proper parts selector required for a particular job: required rate of feed, required orientation, size of parts, shape of parts, weight of part, center of gravity, fragility, hopper capacity, etc. A bearing ball, for example, can be fed by nearly every type of parts selector. Some of them will be faster than others, some will offer less tumbling, some will have greater storage capacity, some will be able to feed many tracks simultaneously, and so on. Each type of feeder has certain advantages and there are so many types that the best solution will probably be attained through the assistance of a supplier who can offer a number of different types.

This article will not try to list parts selectors by types of parts to be fed due to this overlapping of capacity. Instead, it will sketch common types of feeders and discuss some of their advantages and disadvantages to assist the user in judging which type is most suitable for a particular operation. The purpose of this article is not to teach the design of parts selectors, but to present their basic principles to the extent that the reader will have a general understanding of their workings when he encounters them. Only a few examples of the use of each type of parts selector are illustrated. The main objective of these examples is to illustrate methods of operation and the reader may apply these principles indefinitely, limited only by his imagination.

Most common types of parts selectors depend upon gravity. This limits the rate at which parts may be selected to the rate of fall and amount of fall required for a given orientation. To increase the output of a selector beyond these limitations requires either additional selectors or multiple capacity within a selector. Multiple tracks are common in both mechanical and vibratory feeders.

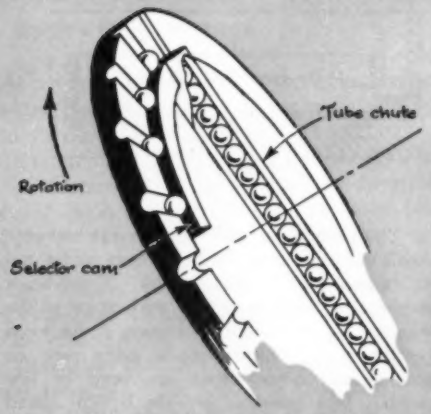
High rates of selection usually imply large feeder capacity, oftentimes making a given feeder impractical by itself. Supplementary hoppers mounted over the feeders with devices to automatically keep the selector level above a minimum are frequently used—adding more complexity and its po-

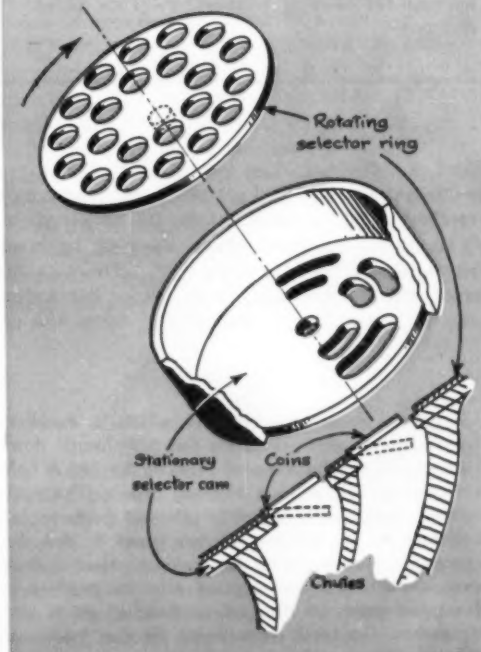




SELECTORS

• ROTARY AGITATOR • ELEVATOR





tential problems. Some large capacity feeders offer both feeding rate and volume—sometimes running 12 to 18 cubic feet.

Complicated orientations further reduce selector capacity. For example, a cube having six sides might be fed at a rate of over 6000 per hour if no orientation as to sides is required. If two particular sides are unusable, one-third of all cubes picked up must be rejected, limiting output to 4000 per hour. If four sides are unusable the maximum would be 2000 per hour. If only one side may be up or forward, the best average would be 1000 per hour. These are round figures since more than the statistical minimum must be picked up to maintain a given average, hour in and hour out.

Few parts fall with the statistical distribution of a cube. Balls, for example, are always in proper orientation and need only be separated and released. Cylinders whose length is substantially greater than the diameter will tend to orient themselves if given time and space enough. Cylinders with greater diameter than length will do the same with axes vertical rather than horizontal. Headed parts will tend to come to rest with the head, or

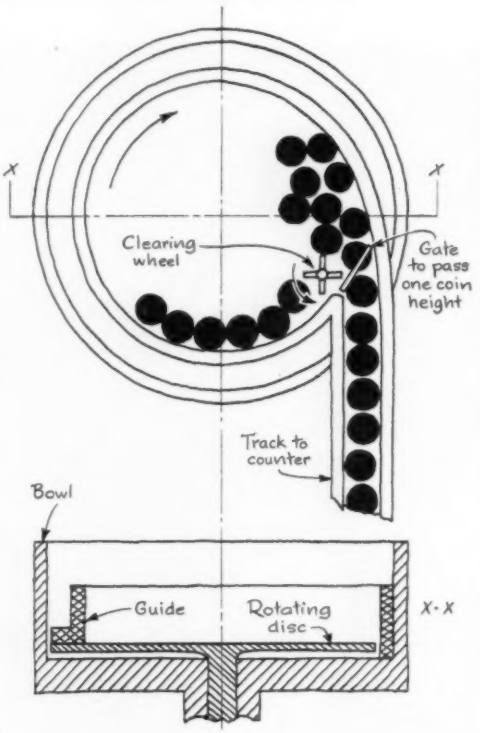


Fig. 2—Example of the rotary disk selector type used as a coin feeder. Parts to be fed are loaded on a rotating disk. Centrifugal force moves parts to the circumference of the disk and off at the track opening if the track is empty. To handle fragile parts such as glass items, conical disks are used at low speeds. Disk selectors provide a high speed method for feeding washers, coins or other flat parts.

heaviest end down, and so on. Almost every type of parts selector will feed a headed part, such as a cap screw or rivet, oriented in its own natural way; i.e., head up, head down, hanging by head, horizontal, head first or stem first. The rotating drum selector for example, feeds headed parts side-by-side with head down very easily, while the rotating selector ring feeder is best for parts fed head up hanging by the head, or stem first end-to-end. The rotating ring selector can be made to feed headed parts side-by-side head down, but it requires one more step in orientation (twisting the track 180 degrees) with potential problems in jamming, overlapping of heads, etc. The first rule, therefore, in choosing a parts selector is to pick the type which has the most natural selection for the part size, shape, weight, center of gravity and other factors. Orientation devices are used as supplements to parts selectors where a natural selection is not practical or available.

Rotary Ring Selectors

This is probably the most common type of parts selector in use. A ring revolves, passing formed

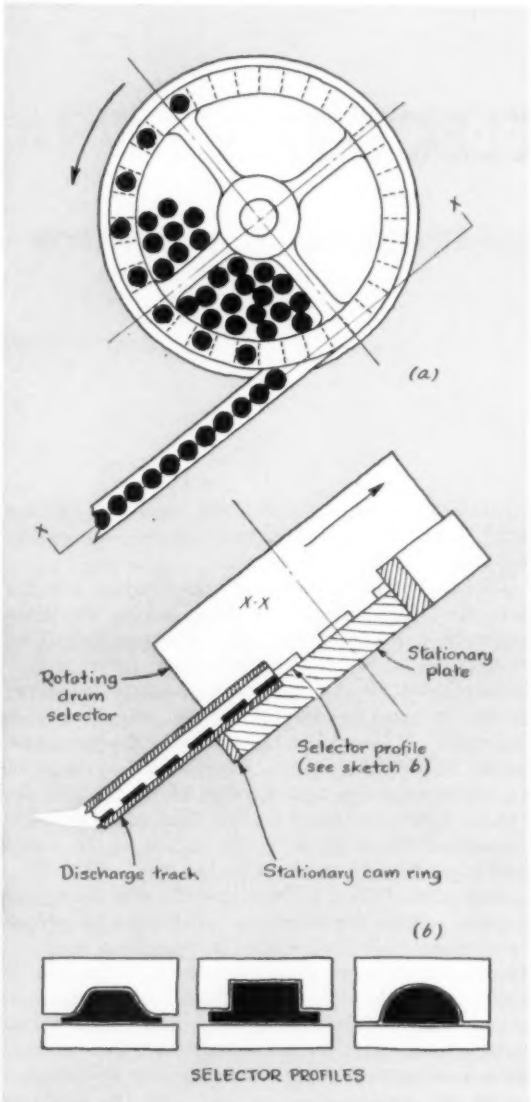


Fig. 3—Rotary drum type selector which is excellent for headed parts that are to be fed with heads down and side-by-side. The mass of parts to be fed is held on a stationary plate by a rotating drum. The rotation of the drum allows suitably oriented parts to fall into cavities in the drum and then pass to the discharge track. *(a)* illustrates the major parts of a drum selector, while *(b)* shows typical selector profiles to feed cupped parts or flanged or headed parts with heads down. To feed parts head up the track can be twisted 180 degrees.

cavities through a mass of the parts to be fed, *Fig.* 1. Statistically, a certain number of parts will fall into these cavities for each revolution of the ring. A certain percentage of these parts will fall correctly oriented and will be retained against gravity as the ring progresses upward in the hopper. Headed parts, which naturally fall head down, will hang by their heads until cammed up for release to the discharge tube, stem first, *Fig.* 1*b*. Short screws in *Fig.* 1*c* are retained by the cam until released to the track, hanging by their heads, side-by-side. Balls, more than one per cavity if desired, are likewise retained by a cam in *Fig.* 1*d*.

A rotating ring selector used for sorting coins into three denominations is illustrated in *Fig.* 1*e*. Slots of three different widths are machined into the stationary plate: slightly larger than the diameter of a dime, slightly larger than a nickel, and slightly larger than a quarter Coins are picked up in the recesses of the rotating selector ring and passed over these slots. The lower edges of the coins are supported by a projection on the stationary plate. Coins fall into their proper slot and are carried off at random. Rate of sorting is governed by the natural rate at which the coins will fall into the recesses of the selector ring and again into the stationary selector slots. Two rows of selector slots are machined into the stationary plate to increase the output to 1000 coins per minute. Compressed air, brushes and spring pressure devices might aid in increasing this rate, but 16 per second is about the maximum natural rate. A higher rate would be desirable, but the physical size of the selector would become unwieldy.

Bushing, eyelets and irregular stampings, turned parts with the same or different ends, and machined parts with irregular shape may be fed and oriented with the ring selector. Additional selection devices such as cams, springs and profiles may be added to make additional selections by ejection of improperly oriented parts (See—AUTOMATION, October 1956). Output depends upon the number of cavities, rate of ring rotation and the part characteristics. Each adaptation has an optimum ring rotation speed beyond which the selector efficiency falls off sharply.

▶ Rotary Disk Selectors

The rotary disk selector, *Fig.* 2, is a very high speed method of feeding washers, coins or other flat parts without orientation as to which side is up. Centrifugal force causes the parts to pass around the circumference of the guide and to enter the track if it is empty. If the track is full, the clearing wheel returns them to the bowl or they remain in line under pressure of the friction of the rotating disk. An angled gate permits only one part thickness to pass under it, rejecting others to the clearing wheel. The feeder sketched in *Fig.* 2 reaches a rate of 2000 coins per minute or 33 per second. This feeder is used in conjunction with the sorter shown in *Fig.* 1*e*, and merely feeds coins of one denomination to a counter. An auxiliary means is necessary to move the coins to the counter since the frictional force of the rotating disk will not maintain the desired rate against much back pressure.

Selection is at a minimum in the rotary disk selector. Profiles on the clearing wheel or built into the guide would permit some orientation, but without tumbling only a limited amount of orientation is possible. Since they keep tumbling at a minimum, similar feeders are used with fragile parts such as glass. Conical disks are used with

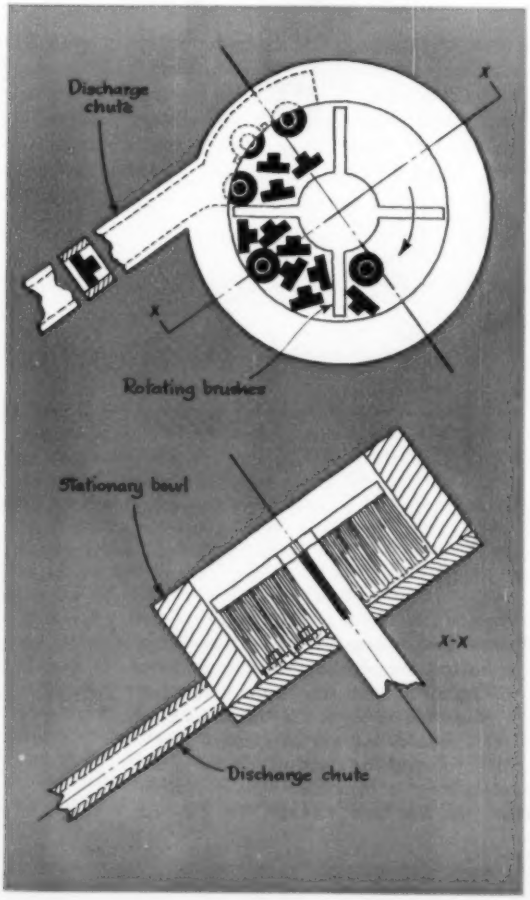


Fig. 4—Sketch of rotary agitator indicates its selective feeding action. Parts to be fed are contained in a stationary bowl. Selection profiles in an area of the bowl wall lead to the discharge chute. Rotating brushes or paddles agitate the mass of parts and cause properly oriented parts to pass through the profiles. These feeders are used on small parts such as washers, eyelets, stampings, pins and screws. Parts such as washers can be fed with considerable force.

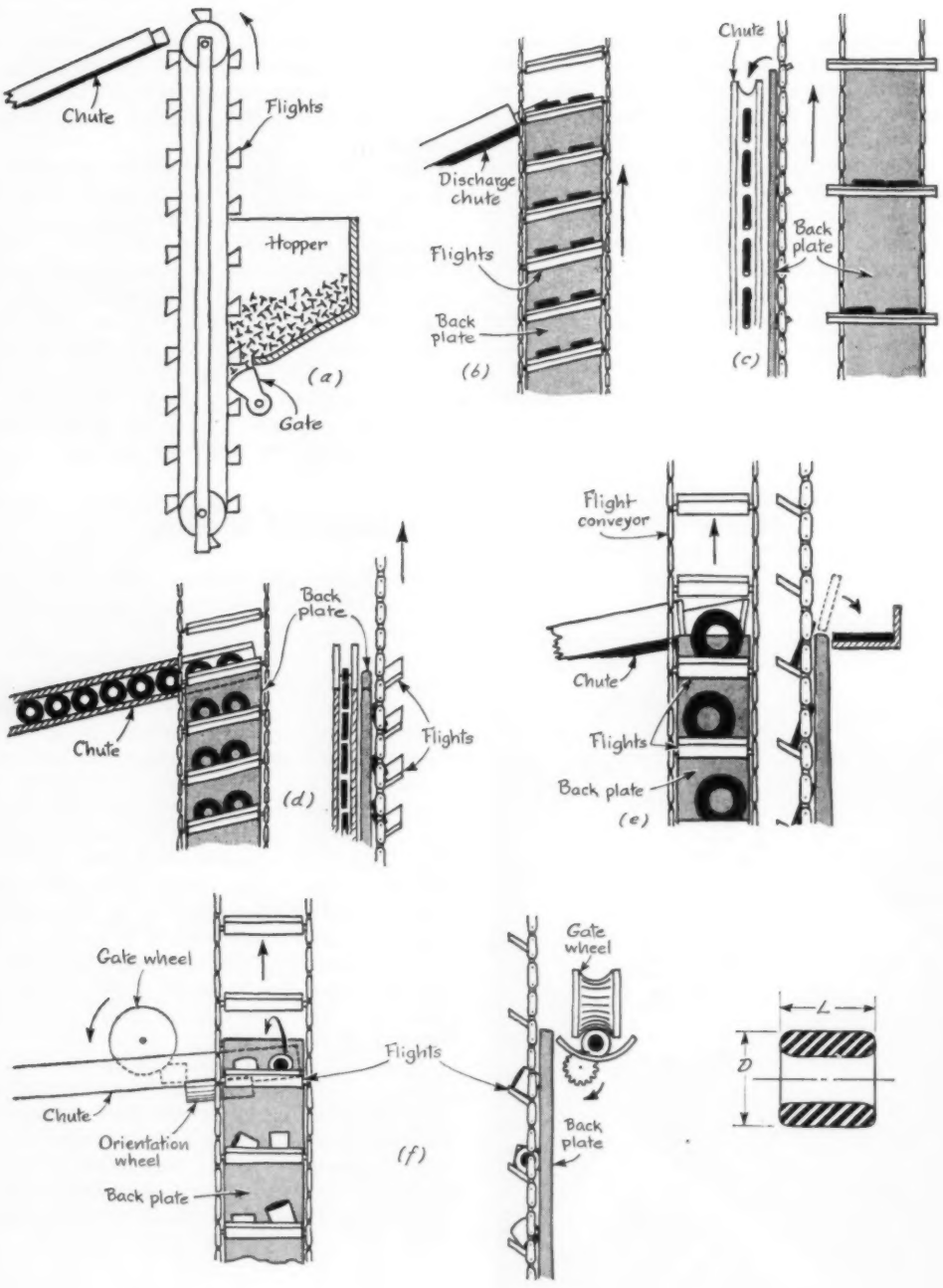


Fig. 5—Illustrations of elevator selectors which are used primarily for feeding large size parts or large quantities of parts. Parts to be fed are placed in a hopper from which they are picked up by flights on an elevating mechanism and then discharged to a chute. Basic arrangement is shown in *(a)*. Depicted in *(b)* is the use of angled flights and a side discharge to feed pins, and *(c)* illustrates the use of straight flights with a rear discharge to feed the same type part. *(d)* and *(e)* illustrate similar alternatives for ring feeding. In *(f)* an orienting arrangement is combined with a straight flight elevator selector to feed rubber bushings with the hole through the bushing properly oriented.

slowly rotating feeders to replace the centrifugal force of the coin feeder. Roller-bearing races are also fed by this means.

Rotary Drum Selectors

The rotary drum selector, *Fig.* 3, is excellent for headed parts on which the head is to be fed down into a track with the parts side-by-side. This is a natural selection with a high rate of efficiency. In this case the profiles are passed around the mass of parts at such a rate as to permit properly oriented parts to enter. On the upward part of the rotation the parts are permitted to enter the track by gravity.

Very thin parts, such as washers and shims, may be easily selected. Parts 0.030-inch and less in thickness are selected, providing their thickness tolerance and flatness are controlled to prevent "shingling" or overlapping in the feeder and track. A minimum of tumbling is another feature of this feeder. Parts seldom travel more than halfway up the bowl before being either accepted into the track or rejected into the bowl. Washers, contacts, nuts, short headed parts, screw machine parts, etc., are all adaptable to this feeder. Headed parts to be used with the head up may pass through a track twisted 180 degrees.

Rotary Agitator Selectors

Rotary agitator selectors differ from the drum type in that the parts are passed through stationary profiles, or slots, by the agitating action of brushes, paddle wheels, etc. Normally they are used on very small parts such as eyelets, electrical contacts, stampings, cupped parts, pins and bushings.

In the example shown in *Fig.* 4 with the bowl at an angle, a tumbling effect offers selection of part side. Used with the bowl in a horizontal plane, washers can be fed with considerable force from the brushes. Screws may be brushed over slots into which they drop, hanging by their heads.

Elevator Selectors

Because of their cost, elevator selectors, *Fig.* 5, are primarily used where large hopper capacities are required for either large part sizes or quantities, or where a high rate of delivery is required. The basic unit consists of a storage hopper through which a conveyor carries flights up to a discharge chute. Angled flights are shown in *Fig.* 5*b* and straight flights in *Fig.* 5*c*.

Cylinders, rods, tubes, and similar items tend to orient themselves lengthwise in the flights, with random orientation of ends. Headed parts such as valves and bolts may be oriented in the track by slotting the bottom of the track to permit the stems to drop and the parts to hang by their heads.

As shown in *Figs.* 5*d* and 5*e*, rings are easily fed with no face orientation into tracks. Additional orientation devices such as probes may be used to sense a given face and reject the undesired faces as in the case of valve seats with chamfered bores.

Shown in *Fig.* 5*f* is an interesting application involving the feeding of rubber bushings having length equal to diameter. Once into the track at random, an orientation wheel rotates the bushings, tending to line up their axes parallel to the track. A gate wheel with a profiled outside surface rejects all bushings except those with a round end forward.

Part Redesign Aids Production

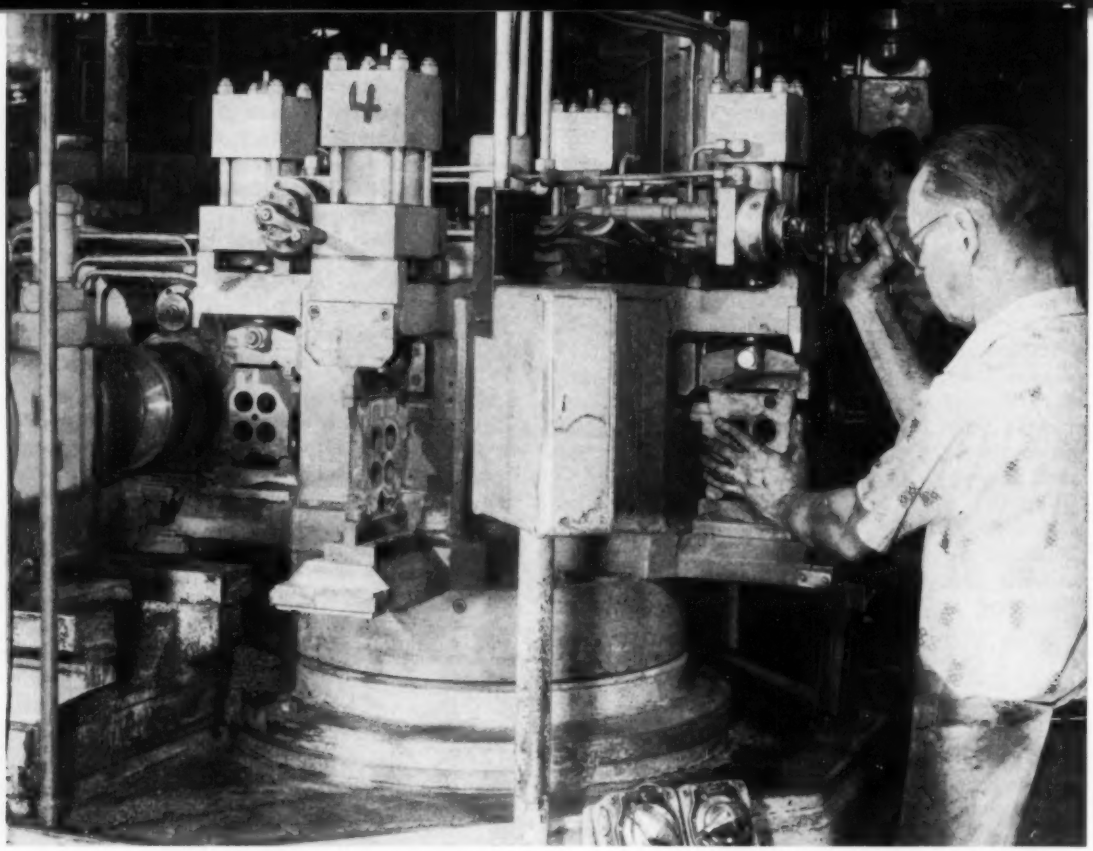
BLOWER WHEELS formed from two pieces of steel can be produced with a considerable improvement in efficiency over previous methods involving the assembly of 50 or more parts. Various size blower wheels are used in Chrysler Corp.'s Airtemp line of air conditioning and heating products. With the redesign of the wheel based on the use of galvanized steel, instead of plain steel, and an improved method of blade forming, production rates varying between 20 to 35 seconds per wheel are possible.

Galvanized steel strip is fed from a coil into a punch press where a section is cut into two pieces and formed into forward curved blades.

A transfer mechanism conveys the two parts to a machine, shown in the background of the illustration, where stamped parts are automatically welded and rolled into a wheel shape. At the next station shown, the rolled sections are manually welded into the wheel form. The wheel is then conveyed to a beading machine that rolls the rims to strengthen the structure.

In the final operation shown, a center disk is placed on the wheel and secured by an expanding operation at the hydraulic press.

The particular combination of stations results from the range of 12 wheel sizes which must be produced.



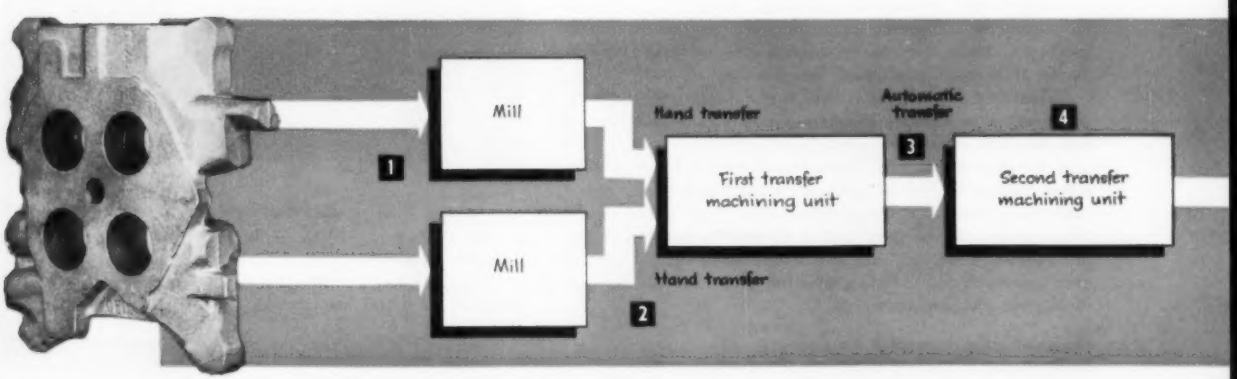
1 Shell molded grey iron castings are straddle milled on indexing type milling machines which permit operators to load and unload parts during the machining cycle. Two milling machines, supplied by Motch and Merryweather Machinery Co., are operated in parallel to keep pace with subsequent operations.

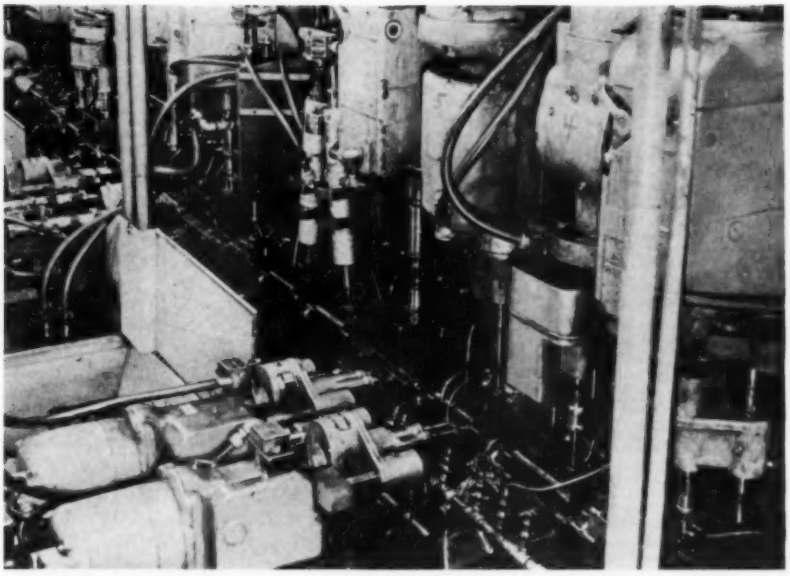
AUTOMATION TODAY

GUN DRILLING LOWERS

INTEGRATED MACHINING

By **FAY H. STROUD,**
Supervisor, Manufacturing Equipment Development, Rochester Products Div., General Motors Corp., Rochester, N.Y.



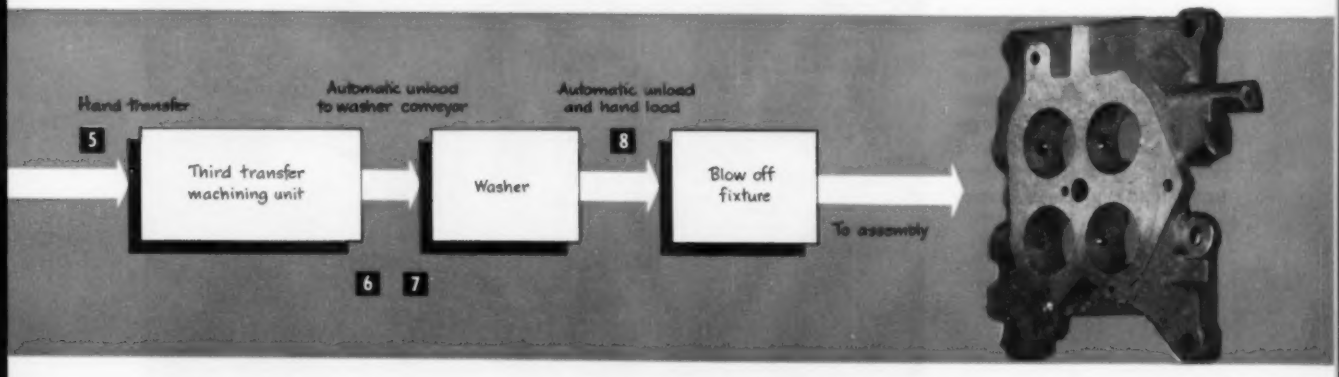


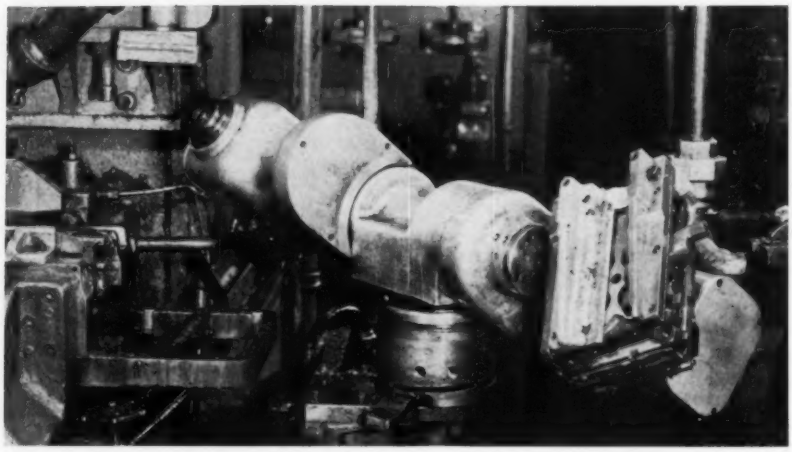
2 Milled castings are manually loaded into this transfer machining unit designed by Rochester products. Four mounting holes are drilled at the first machining station; two diagonal holes are reamed at the second station and these are used for locating at all subsequent machining stations. Castings are indexed by a hydraulically operated transfer bar and are hydraulically clamped at each machining station.

COSTS IN LINE

INTEGRATED OPERATIONS and continuous flow are important objectives of modern mass production industries. Continuous flow production lines reduce or eliminate in-process inventories between operations, save floor space, reduce material handling costs, and in general permit better control of the manufacturing operation.

Rochester Products Div. of General Motors has in operation a continuous line for machining throttle bodies for 4-barrel carburetors. On this machining line, shell molded iron castings are completely machined, washed, and blown off, with little or no bank between operations. A total of 69 operations is required for each casting, and parts are processed at an average rate of 275 pieces per hour. An individual casting is completely machined





3

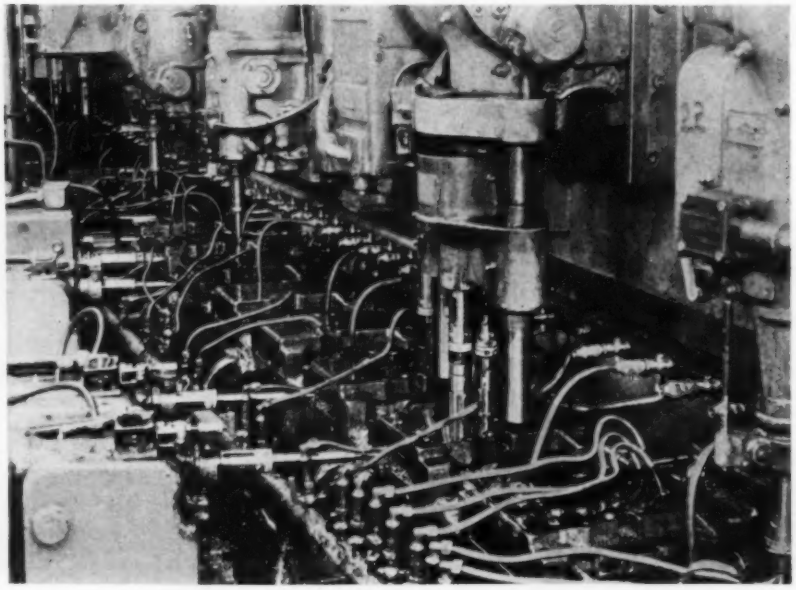
This handling device automatically moves each workpiece from the first transfer machining unit to the second. During this movement the castings are turned upside down and also rotated 90 degrees in a horizontal plane.

and ready for assembly approximately 20 minutes after it has been started through the line. In its trip through the line, the casting passes through one of two milling machines, through three transfer machining units, through a washer, in and out of a special blowoff fixture, and on to assembly.

Since coolant is used for all machining operations except milling the faces, the continuous flow principle assumes added significance. If machined castings are banked before washing, the mixture of cast iron dust and coolant tends to solidify in the smaller holes and passages, with the result that cleaning becomes more expensive and less satisfactory.

The three-section transfer machining installation is approximately 85 feet long, with 59 stations and 89 individual machining operations, including duplicate operations on the third section. Machining heads are mounted on hydraulically operated slides which permit quick retraction for tool changes. Electromechanical probes are incorporated for the small holes where drill breakage is more likely to occur. These probes will detect a broken tool or missing hole and stop the machine. Tools are preset for depth to minimize down time for tool changes.

The gun drilling of the shaft holes is of special interest. These holes are held within limits of 0.315-0.316-inch diameter and must be straight enough over a length of approximately 5 inches to permit a 0.314-inch diameter gage to pass freely. The holes are drilled from the solid with one pass, and with a jump feed across the bores. The spindle speed is 8000 rpm. Pressure of the coolant



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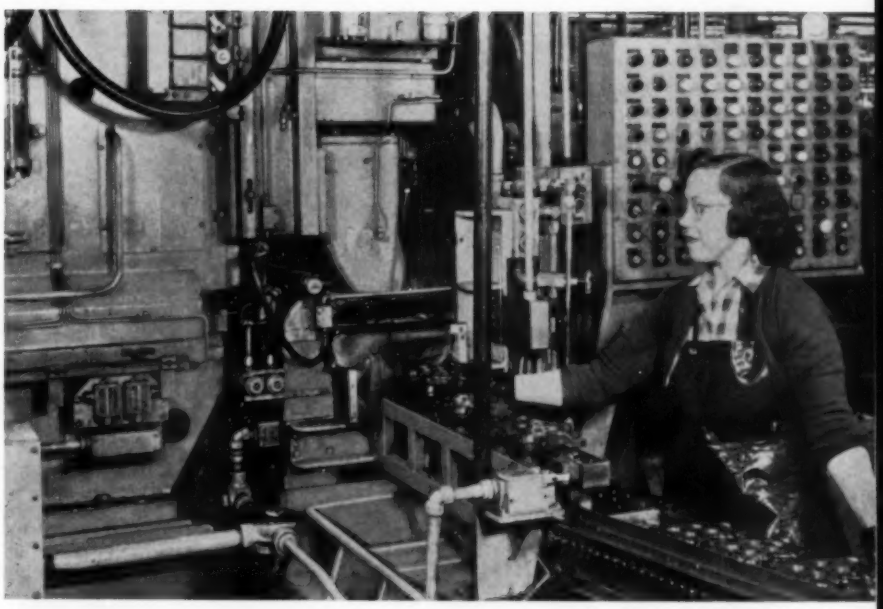
Most of the machining operations are completed in this second transfer machining unit; which was also designed by Rochester Products. Large volumes of coolants required are supplied to each station from the plumbing system shown.



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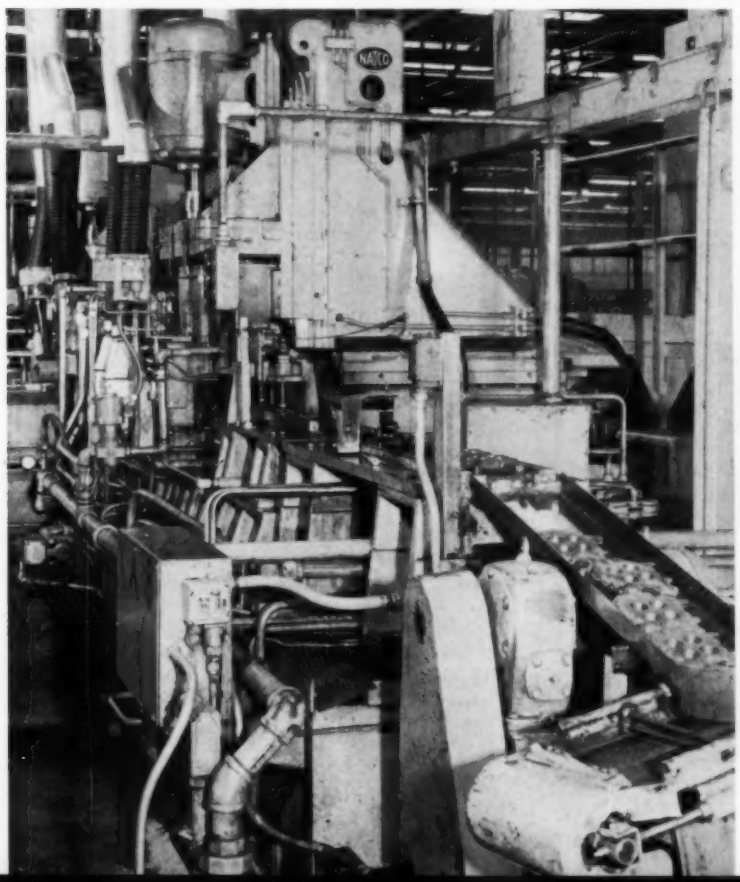
Parts coming from the second transfer machining unit by conveyor at right are loaded into third unit by an operator. The four throttle bores in the parts are rough and finish reamed, and shaft holes are gun drilled in this third unit, which was designed and built by National Automatic Tool Co. These are critical operations requiring machining cycles three times as long as cycles on the first two transfer units, so this unit performs each operation on three parts simultaneously.

to the gun drills is maintained at 600 psi. Proper filtration of the coolant is obtained by passing it through a Barnes Magnetic Separator, a settling tank, a Sharpless Centrifuge, and finally a reservoir.

Tolerances for hole location, diameter, straightness, and finish are consistently held with this process. Prior to gun drilling, the operation required two drilling and one or more reaming operations to produce an acceptable shaft hole. An anlysis of all cost factors involved in the operation indicates that the cost per hole of gun drilling is substantially lower than that of the conventional method formerly used.



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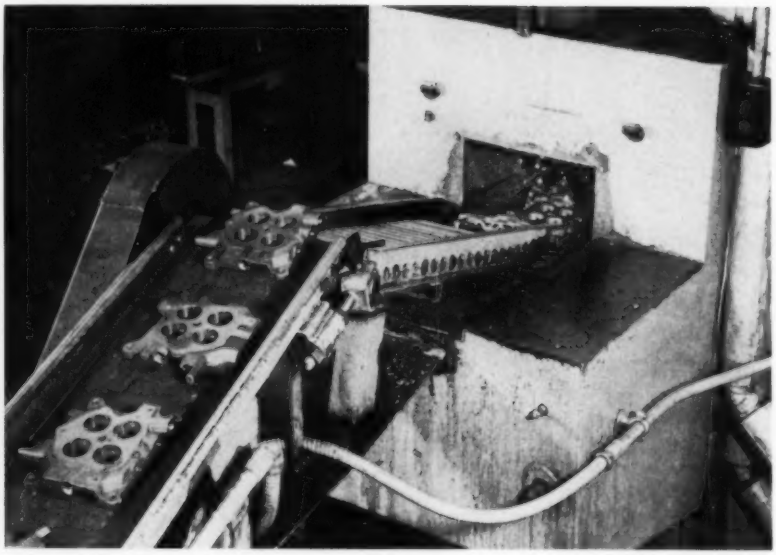
Parts automatically unloaded from the third transfer unit slide onto a belt conveyor leading to a washer out of this picture to the right.



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Finished parts from the machining operations travel through this Ransohoff washer on a continuously moving steel mesh belt. They pass through hot water jets, air blowoffs, and finally a gas heated drying section.

The experience gained on this particular gun drilling operation indicates that, beyond the basic principles involved, there is no set pattern which can be used for all gun drilling applications. To successfully gun drill the shaft holes, it was necessary to deviate from the initial plans for coolant, the filtering system, feed rate, grinding of the drills, and drill bushings. This required considerable development during trial runs, but the end result was well worth the effort involved. The accompanying diagram and photos illustrate some of the features of this modern continuous flow machining line.

8

Washed castings drop on a belt conveyor at the unload end of the washer. At the next work station an operator loads each casting in a special blowoff fixture. To insure cleaning of the more critical holes and passages, nozzles are automatically sent into the holes and retracted during the blowoff cycle. After this operation, the castings are sent to the assembly area.

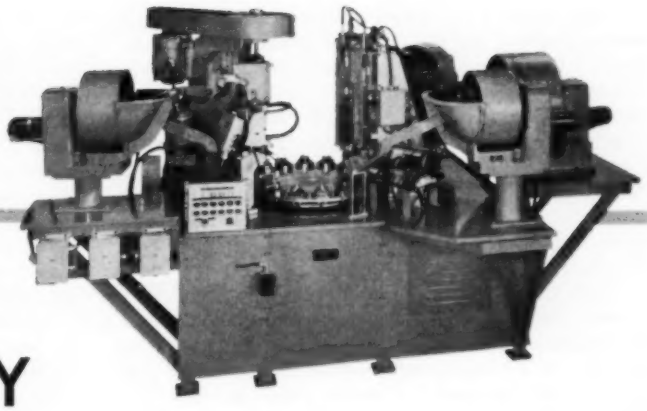


Fig. 1—Standard equipment, such as KDI hopper feeders, has been grouped around a Ferguson indexing table to create a ball stud socket assembly machine.

SUBASSEMBLY AUTOMATION FITS A BUDGET

Ideally suited to automatic assembly are smaller subassemblies and end items which are needed in quantity, composed of relatively few parts and free from major design changes. With ingenuity, automatic assembly in such cases can be planned and accomplished in progressive steps using standard equipment at costs within reach of the average firm.

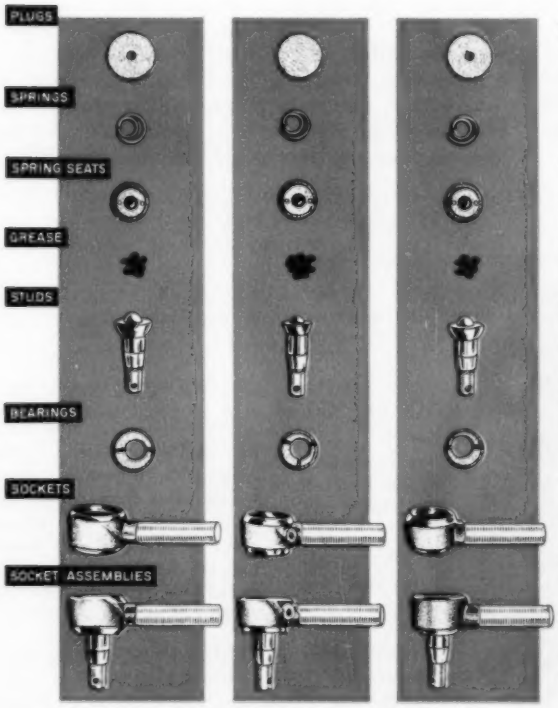


Fig. 2—The assembly machine shown in *Fig.* 1 can handle three different styles of socket assemblies. To change over equipment for different styles requires less than one hour.

By W. E. HORENBURGER
KDI Corp., Rochester, N. Y.

MANY ARE THE WORDS written about major automation installations as typified by a $750,000 assembly machine engineered to produce complex automobile engine cylinder heads in high volume. Yet in American industry today the potential number of such installations is so limited as to evoke from the average manufacturing and process engineer only casual technical interest in techniques used. Normally an extensive installation represents a colossus having only the remotest relation to his product and problems, and no relation whatsoever to his limited budget.

If automatic parts handling equipment is to be of value to the average "Widget" manufacturer, it must be within reach of his annual appropriation for "cost reduction and methods improvement" projects. To automate the manufacture of the entire product would require such a substantial initial investment as to discourage all but the wealthiest of middle sized businesses. But considered subassembly by subassembly, it is possible to effect, in progressive stages, an automation program that on a yearly basis is within reach of most manufacturers, and which over a five-year period will produce a notable improvement in productive efficiency. Many everyday items, ranging from toilet float valves through ball-and-socket joints to

electric frying pans are currently being assembled economically in high volume with automatic equipment. Characteristically, model changes are not frequent, not more than eight or ten component parts must be handled, and the cost of suitable handling equipment can be spread over three to five years without fear of technical obsolescence. Such small assemblies can be automated for amounts ranging between $50,000 and $80,000 with equipment that can be designed to accommodate two or three sizes of the principal parts involved.

Projects of this nature would require neither electronic brains to control the automated line nor a six-figure appropriation; only the engineering ingenuity of an equipment supplier to break the assembly into its basic elements would be required. Then each component can be analyzed, proper handling techniques established for each part, and all integrated into a single overall assembly plan. Using standard hopper feed mechanisms, ingenious chuting and orienting techniques, inserters and escapements to position and meter the component parts, precision index tables to carry the work from station to station—all tied together with suitable interlocking electrical, hydraulic, or pneumatic controls—it is possible to develop multistation assembly machines for less than $5000 per station.

Such an approach makes possible an eight or ten-station assembly machine capable of replacing four to eight operators for less than $50,000 in expenditures. With a life expectancy of five years, a machine which will pay for itself in two can prove to be a very worthwhile investment.

A typical assembly machine of this type is shown in *Fig.* 1. Designed and built by the KDI Corp. this automotive tie-rod ball stud socket assembly machine combines several standard KDI drum hoppers, a Ferguson Intermittor index table and two operator stations in one integrated unit. Three different ball stud socket assemblies, each consisting of six components, *Fig.* 2, are assembled by this machine at the rate of 20 per minute, using two operators. Interchangeable holddown fingers for the nest, and removable jaws for the stud and bearing inserters permit the operator to change from one style of socket to another in less than one hour.

In addition to the parts which are automatically handled, a metered quantity of lubricant is injected during the build-up cycle. When all parts are in place, properly located and checked, the closure is effected by a spinning head.

Sixteen nesting fixtures on the index table carry the sockets under each of the 16 workstations in sequence as shown in *Fig.* 3.

To insure performance the assembly machine is equipped with a series of electrical interlocks which include the following precautionary circuits:

1. If socket is missing machine will stop.
2. If bearing is not inserted machine will stop.
3. If plug is not inserted machine will stop.
4. If probe shows any parts missing at spin station, the spinning head will not operate; the machine will not stop.
5. If fixture is empty spin head will not operate.
6. If spin head has not fully retracted machine will not index.
7. If assembly is not ejected machine will stop.
8. Two emergency stop buttons are provided, one for each operator.

There need be no stinting on engineering or construction features in equipment of the type illustrated in this article. A machine can be designed to "take it" under 24 hours a day, seven days a week operation. As a basic piece of automated equipment it becomes a "pilot plant" operation that can, with a minimum of capital investment, provide operating experience to management, production engineering, and plant maintenance groups.

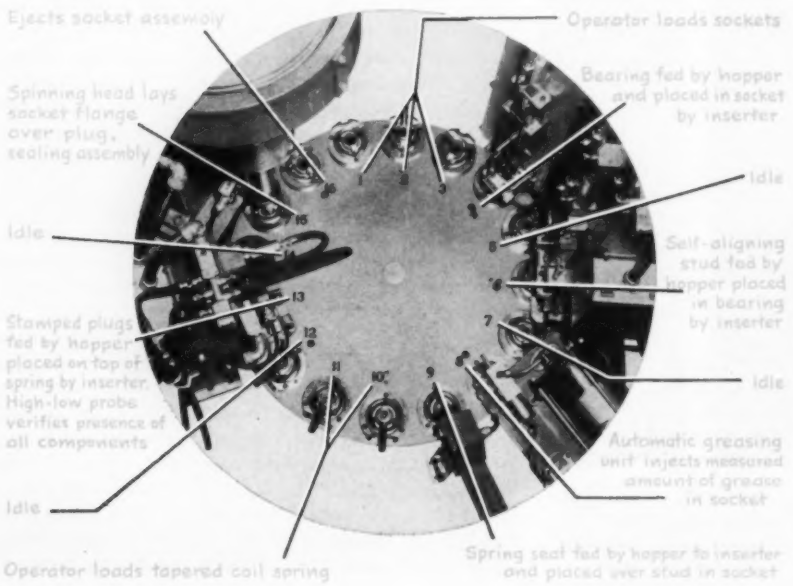
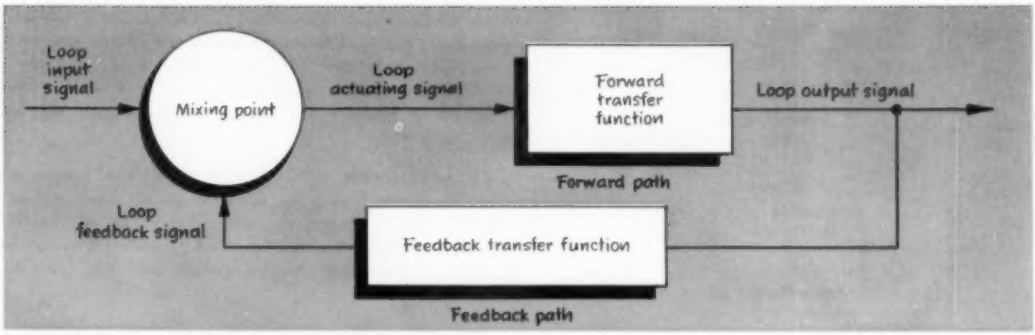

Ejects socket assembly
Operator loads sockets
Spinning head lays socket flange over plug, sealing assembly
Bearing fed by hopper and placed in socket by inserter
Idle
Idle
Self-aligning stud fed by hopper placed in bearing by inserter
Stamped plugs fed by hopper placed on top of spring by inserter. High-low probe verifies presence of all components
Idle
Automatic greasing unit injects measured amount of grease in socket
Idle
Spring seat fed by hopper to inserter and placed over stud in socket
Operator loads tapered coil spring

Fig. 3—The worktable is provided with 16 nesting fixtures which index through the stations as shown. Six components and a metered quantity of lubricant are combined into assemblies at rate of 20 per minute.



FEEDBACK CONTROL SYSTEMS

TO FULFILL the requirements of the Institute of Radio Engineers for a complete and self-consistent terminology applicable to control systems with feedback, committees of the IRE developed a compromise among existing terminologies used in the electrical field. AUTOMATION presents here the definitions from this work, "IRE Standards on Terminology for Feedback Control Systems." Paragraph numbers shown are the same as in the standard. It is hoped that presentation of such definitions will assist in the adoption of standardized language in the field of automatic control.

2.1.1. LOOP INPUT SIGNAL. An external signal applied to a feedback control loop.

2.1.2. LOOP OUTPUT SIGNAL. The controlled signal extracted from a feedback control loop.

2.1.3. LOOP FEEDBACK SIGNAL. The signal derived as a function of the loop output signal and fed back to the mixing point for control purposes.

2.1.4. LOOP ACTUATING SIGNAL. The signal derived by mixing the loop input signal and the loop feedback signal.

2.1.5. LOOP ERROR SIGNAL. The loop actuating signal in those cases in which it is the loop error (See 2.4.10).

2.1.6. LOOP RETURN SIGNAL. The signal returned via a feedback control loop to a summing point, in response to a loop input signal applied to that summing point, and subtracting from the loop input signal.

The loop return signal is a specific type of loop input signal.

2.1.7. LOOP DIFFERENCE SIGNAL. The output signal from a summing point of a feedback control loop produced by a particular loop input signal applied to that summing point.

The loop difference signal is a specific type of loop actuating signal.

2.2.1. MIXING POINT. In a block diagram of a feedback control loop, a symbol indicating the relationship of one output to two or more inputs, such that the value of the output at any instant is a function of the values of the inputs at that instant.

If a mixing device in practice contains dynamic elements, these shall be considered as transfer elements in one or more of the signal paths entering or leaving the mixing point.

2.2.2. SUMMING POINT. A mixing point whose output is obtained by addition, with prescribed signs, of its inputs.

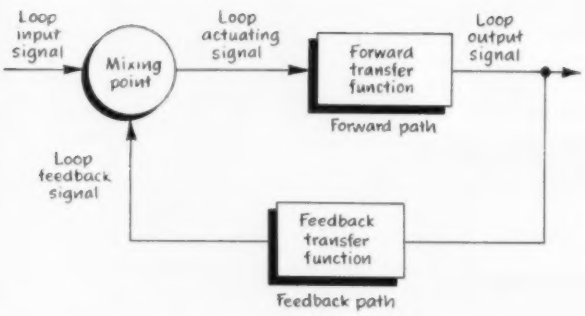
2.2.3. MULTIPLICATION POINT. A mixing point whose output is obtained by multiplication of its inputs.

2.2.4. FORWARD PATH. In a feedback control loop, the transmission path from the loop actuating signal to the loop output signal.

2.2.5. FEEDBACK PATH. In a feedback control loop, the transmission path from the loop output signal to the loop feedback signal.

2.2.6. THROUGH PATH. In a feedback control loop, the transmission path from the loop input signal to the loop output signal.

2.3.1. TRANSFER FUNCTION. A relationship between one system variable and another that enables the second variable to be determined from the first.



2.3.2. TRANSFER RATIO. The transfer function from one system variable to another in a linear system, expressed as the ratio of the Laplace transform of the second variable to the Laplace transform of the first variable, assuming zero initial conditions.

2.3.3. LOOP TRANSFER FUNCTION. The transfer function of the transmission path formed by opening and properly terminating a feedback loop.

One example of proper termination is a zero impedance generator driving the opened loop, and an output termination for the opened loop equal to the impedance facing the generator.

2.3.4. LOOP TRANSFER RATIO. The transfer ratio of a loop return signal to the corresponding loop difference signal.

2.3.5. FORWARD TRANSFER FUNCTION. In a feedback control loop, the transfer function of the forward path.

2.3.6. FEEDBACK TRANSFER FUNCTION. In a feedback control loop, the transfer function of the feedback path.

2.3.7. RETURN TRANSFER FUNCTION. In a feedback control loop, the transfer function which relates a loop return signal to the corresponding loop input signal.

2.3.8. DIFFERENCE TRANSFER FUNCTION. In a feedback control loop, the transfer function which relates a loop difference signal to the corresponding loop input signal.

2.3.9. THROUGH TRANSFER FUNCTION. In a feedback control loop, the transfer function of the through path.

2.3.10. ACTUATING TRANSFER FUNCTION. In a feedback control loop, the transfer function which relates a loop actuating signal to the corresponding loop input signal.

2.4.1. FEEDBACK CONTROL LOOP. A closed transmission path, which includes an active transducer and which consists of a forward path, a feedback path, and one or more mixing points arranged to maintain a prescribed relationship between the loop input signal and the loop output signal.

2.4.2. FEEDBACK CONTROL SYSTEM. A control system, comprising one or more feedback control loops, which combines functions of the controlled signals with functions of the commands to tend to maintain prescribed relationships between the commands and the controlled signals.

2.4.3. FEEDBACK CONTROL SYSTEM, LINEAR. A feedback control system in which the relationships between the pertinent measures of the system signals are linear.

2.4.4. FEEDBACK CONTROL SYSTEM, NONLINEAR. A feedback control system in which the relationships between the pertinent measures of the system input and output signals cannot be adequately described by linear means.

2.4.5. FEEDBACK CONTROL SYSTEM, QUASI-LINEAR. A feedback control system in which the relationships between the pertinent measures of the system input and output signals are substantially linear despite the existence of nonlinear elements.

A system can be either quasi-linear or nonlinear, depending upon operating conditions and performance requirements.

2.4.6. FEEDBACK REGULATOR. A feedback control system which tends to maintain a prescribed relationship between certain system signals and other pre-determined quantities.

This definition is intended to point out the fact that some of the system signals in a regulator are adjustable reference signals.

2.4.7. SERVOMECHANISM. A feedback control system in which one or more of the system signals represent mechanical motion.

It should be noted that servomechanism *and* regulator *are not mutually exclusive terms; their application to a particular system will depend on the method of operation of that system.*

2.4.8. COMMAND. An independent signal from which the dependent signals are controlled according to the prescribed system relationships.

2.4.9. DISTURBANCE. An undesired command.

2.4.10. LOOP ERROR. The desired value minus the actual value of the loop output signal.

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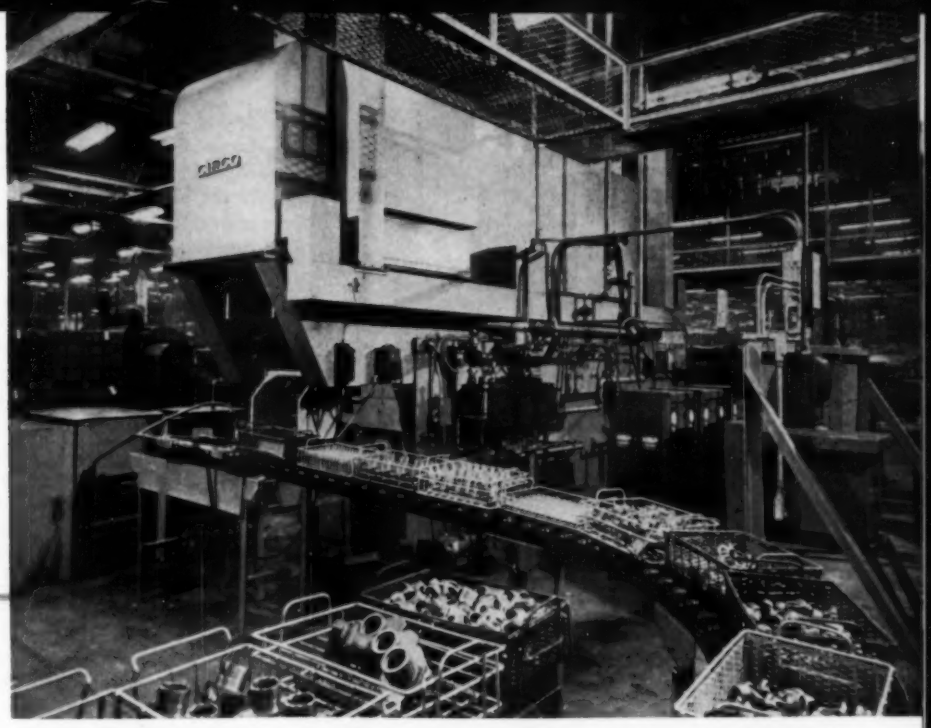


Fig. 1—Ultrasonic cleaning installation at Saginaw Steering Gear Div., General Motors Corp. View of outlet end of installation shows baskets of cleaned parts which have been automatically unloaded from machine at end of cleaning cycle.

ULTRASONIC CLEANING INSTALLATION

HANDLES PRODUCTION QUANTITIES

Increasingly critical manufacturing requirements have led industry to search for more efficient techniques for cleaning workpieces in production quantities. One solution to important cleaning problems involves ultrasonics —and modern techniques permit its use as part of the production line.

ULTRASONIC cleaning has, within the short span of five years, evolved into a technically important and economically practical production process. In the earliest applications, transducer mechanisms were suitable only for cleaning very small metal parts. However, since 1952 significant strides have been taken until, today, transducers have developed into potent realities, offering important technical and economic advantages to mass cleaning operations.

Basic to any discussion of sonics is the fundamental knowledge that sound consists essentially of a wave series of condensations and rarefactions passing through an elastic medium. Sound waves can traverse solids, liquids or gases at a rate in direct proportion to the medium's density. The amplitude, or intensity of the sound, as well as its

frequency, depends on the energy and vibratory rate of its source.

In metal cleaning practice, ultrasonic vibrations —vibrations pitched too high to hear—in medium or large scale processing equipment are produced by an immersion-type transducer, which consists of a stainless steel, hermetically sealed cartridge containing a barium titanate crystal. The transducer is energized by passing a discontinuous current through it which causes the barium titanate crystal to alternately lengthen and shorten at a rate determined by its natural resonant frequency. The modern transducer can be used either singly or in arrays of whatever number is required to irradiate a cleaning tank with ultrasonic vibrations and can produce sufficiently high power outputs for any conventional cleaning process. Besides irradiating standard degreasing solvents, transducers may be used in virtually any liquid, including those which are conductive, corrosive, combustible, volatile and explosive. They work effectively in all types of common cleaning operations as well as in pickling, descaling, plating, textile dyeing, leather tanning and other special applications.

Modern transducers can be tuned to operate in parallel from a single power source. In general, tuning is never so critical as to reduce the effectiveness of sonic output at slight shifts in the input frequency. This is important since it relieves the operator from undue attention to the generator in order to constantly readjust the system for peak effectiveness at every minor fluctuation.

When placed side by side in any processing vessel, transducers reinforce one another to bask the entire liquid volume with strong and uniform ultrasonic vibrations. Transducers are easily installed in a tank of any type since they can be seated on vessel floors or affixed to the walls without complicated renovation of existing systems.

Electronic drivers supply a controlled on-off current to the single transducer or the battery of transducers being energized. Currently available are commercial generators ranging from 500 watts to over 20,000 watts—outputs which are adequate for activating from two to forty sonic drivers. The determination of total power required by a given battery of transducers is based on the required power input for each transducer, the position of all elements suspended in the tank, quantity of liquid contained in the tank and the geometrical relationship of the transducers to the pieces that are immersed in the bath. Preliminary trials establishing the power relationship with respect to time, size, shape of work, depth of liquid and temperature also must be assayed before the power requirement is calculated.

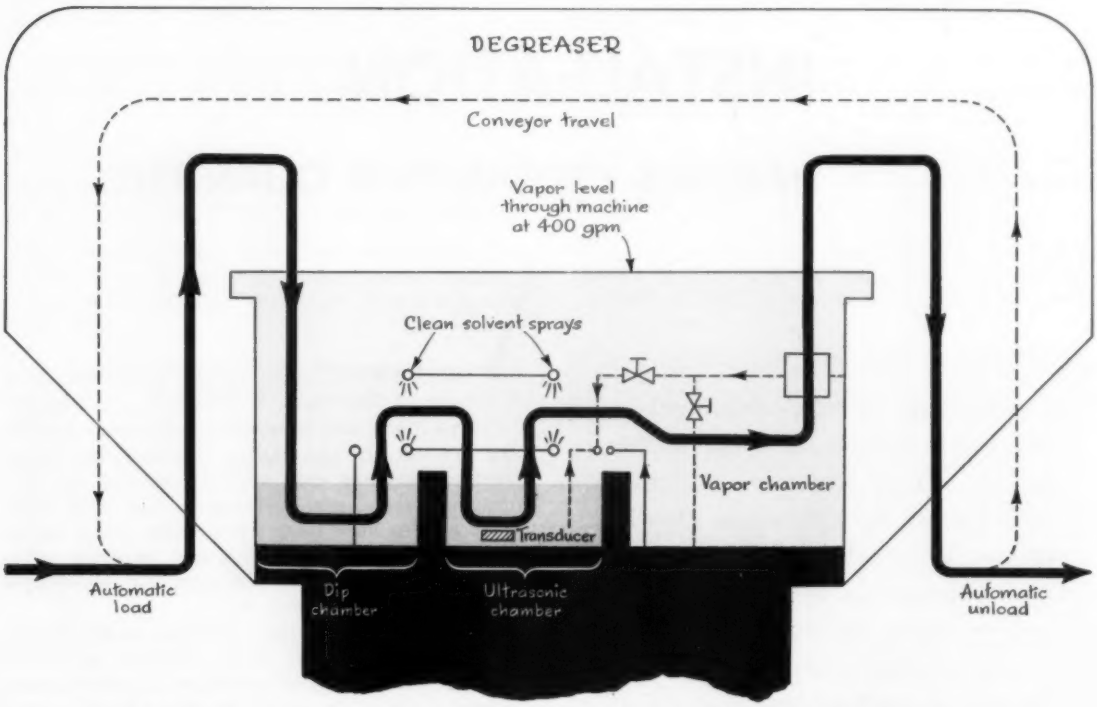


Fig. 2—Cleaning cycle consists of three main stages: Initial cleaning by boiling solution and spray in dip chamber; follow-up cleaning in solution subject to ultrasonic irradiation and in second spray; and final cleaning by vapor.

Why It Cleans

The efficient scrubbing action of ultrasonic cleaning is due to the cavitation effect which is produced by the intense alternating compression and decompression cycle resulting from rhythmic elongation and contraction of the barium titanate crystal in the sonic transducer. The extreme alternating pressure differential thus created — the formation of countless tiny vapor bubbles as the pressure is reduced and their violent collapse as the pressure rises to a maximum—literally tear dirt particles from the surfaces of the objects being treated. When a transducer is submerged in a degreasing solvent, such as trichlorethylene or perchlorethylene, parts in the solvent are subjected to a brief period of ultrasonic bombardment and vigorous cleaning which is not achieved by any conventional system of agitation.

The typical cleaning cycle, as it has been developed, consists of a customary hot treatment by solvent liquid, spray or vapor immersion, then exposure to the cavitation forces of ultrasonic vibration. The tiny explosions characterizing cavitation remove grease and oil, and tear loose such insoluble solids as abrasive residue and metal chips from crevices, recesses, blind holes and screw threads. Even porous surfaces are left microscopically clean.

Transducers and ultrasonic generators are currently being manufactured in compact units for installation in new or existing degreasing machines which operate with a liquid solvent immersion stage. Ultrasonic equipment is not designed for cleaners of the vapor type.

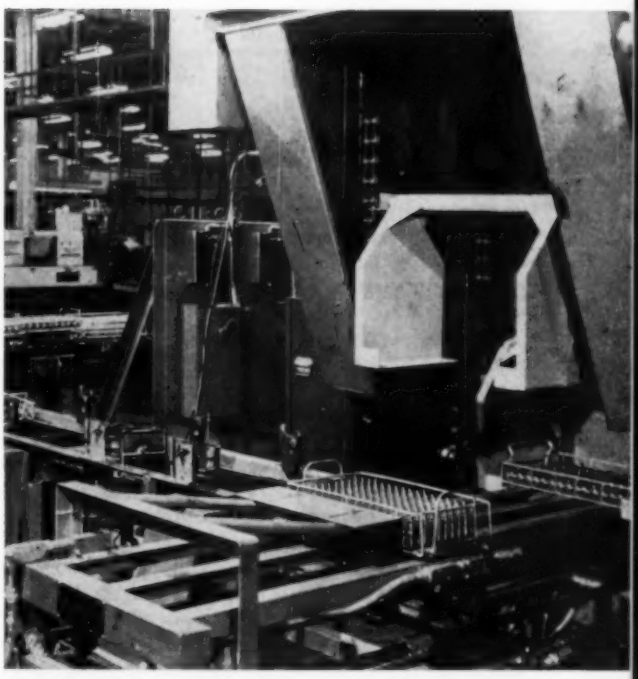


Fig. 3—Baskets are loaded onto and unloaded from hangers on conveyor by pneumatic devices. System co-ordinates pneumatic action with movement of hangers to load a basket onto conveyor every 15 seconds.

Technical Considerations

The key to maximum efficiency, with respect to minimum power consumption, is the resonant frequency at which an ultrasonic unit is operated. Since the intensity of cavitation is approximately proportional to the amplitude of the vibration, which is in turn inverse to the frequency at any given level of power input, it develops that relatively low sonic frequencies are desirable for the maximum cleaning effect.

For example, cavitation may be expected to be about three times as intense at 40,000 cycles per second as it would be at 100,000 cps for any power constant. Conversely, for a level of intensity required for a given operation, a frequency of 40,000 cps would require only a third of the power input that would be needed for 100,000 cps. While still lower frequencies produce even more effective cavitation, it is impractical to approach the audible range whose upper reaches are defined as 20,000 cps.

An important advantage of the relatively low frequencies over the higher frequencies is their far greater power to penetrate convolutions and negative contours. In addition, the shadowing effect of lower ultrasonic frequencies is not appreciable at 40,000 cps. In most instances, highly complex metal surfaces can be completely cleaned by exposure to low-frequency, high-amplitude vibrations. Standing waves, random reflections and interferences which frequently cancel out the ultrasonic effects in some portions of the cleaning bath, are avoided. Low frequency ultrasonic radiations, which are polydirectional, do not have to be focused to be effective, as do high frequency beams.

Production applications have established that the following power outputs at 40,000 cps will produce effective results: (1) 8 watts per square inch of transducer surface for easy cleaning jobs; (2) 10 watts per square inch for hard cleaning jobs, recesses, cavities, blind holes; and (3) 10-15 watts per square inch for extremely difficult cleaning jobs.

Production System

Though not a new installation, the ultrasonic cleaning facilities at Saginaw Steering Gear Div. of General Motors Corp. illustrate the modern approach to exacting cleaning requirements.

Accompanying the manufacture of steering gear assemblies there is the inevitable accumulation of grease, oil, compounds, chips and entrapped dirt filming the components. Leaving as much as one particle of abrasive residue on steering gear in-

ternals during cleaning is likely to cause either immediate or eventual damage to the operating unit. Despite every effort to effectively clean the critical components by conventional means, production schedules were disrupted either through a high rejection factor or through a slowdown in the cleaning process as more time was given to solvent exposure.

Saginaw approached Circo Equipment Co. for assistance in developing automatic cleaning equipment. From a collaboration of Saginaw's plant engineers and Circo's equipment designers evolved a fully automated high speed cleaning machine with integral ultrasonic chamber, *Fig.* 1.

Designed to load, transport, clean and then unload steering gear parts stacked in baskets, the Circo ultrasonic cleaning machine is mechanized to reduce human attendance and maintenance to a minimum. Its present 50-ton capacity is more than sufficient to handle the output of the machining lines, and of most importance, any reasonable acceleration will not reduce cleaning thoroughness. Since ultrasonic cleaning effectiveness is not intimately related to exposure time, but to the electrical energies involved, a speed-up is no cause for concern.

Machined parts emerge from the production area, are routed to stations where they are inspected, placed in baskets, and then moved via gravity and mechanical conveyors to a loading table at the entrance of the cleaning machine. A pneumatic loading shuttle actuated by a limit switch feeds the baskets onto individual moving hangers attached to a power driven conveyor which passes through the machine. The first of three cleaning stages to which parts are subjected, is hot trichlorethylene vapor, *Fig.* 2. Passing down through the vapor chamber, baskets dip into a sump containing boiling (188F) trichlorethylene solvent which vigorously scrubs off heavy and accessible dirt deposits from surfaces and penetrates crevices and cavities to remove some of the trapped contaminants.

The baskets then move slowly and gently through the boiling sump for 30 seconds and lift into a section where cooler, distilled trichlor is pressure sprayed against the parts to force out any remaining residue. Four-hundred gallons per minute of pure distilled solvent, flushing through the spray chamber, are supplied from the vapor level condensing coils and the auxiliary solvent recovery still. Clean solvent can be drawn from any compartment, through a system of pumps and lines, for discharge through the spray nozzles.

At this point, parts can be called "clean", but to achieve microscopic cleanliness further treatment is necessary.

The baskets are directed through a 140F trichlorethylene bath subjected to 40,000 vibrations per second from three sets of ten transducers each. When baskets dip into the bath, they set up violent turbulence approaching explosive force. The scrubbing action, not restricted to the exterior surfaces, tears loose microscopic particles of dirt from blind holes, crevices, inaccessible spots and invisible pores. Cleaning time rarely exceeds 1½ to 4 seconds — extended immersion will not further clean the parts.

The trip through the ultrasonic area consumes 20 seconds. From this stage, the baskets are directed through another clean solvent spray section, into an atmosphere of hot solvent vapor and onto a discharge conveyor system. As hot parts are lifted into the cooler air, all condensed solvent still remaining quickly evaporates, leaving an impeccably clean and dry product. Baskets are automatically unloaded from the hangers by a pneumatic mechanism similar to one used in the loading action, *Fig.* 3, and slid onto a power conveyor protected with limit switches to prevent congestion at this point.

What's Your Problem?

DO YOU HAVE a knotty problem in your automatic operations or those you plan to install? The AUTOMATION Problem Forum, a special feature department to be found in the rear of this issue, offers a unique service in which you will be interested.

To avail our readers of automation information and to tap the vast reservoir of practical know-how across industry, editorial space is devoted to the presentation of both problems and suggested solutions to the problems. This free exchange of ideas and information, as can be seen from the format of the Problem Forum, can be accomplished without violating the rights of privacy of individuals or firms. Why not take advantage of this service—what's your problem?

STANDARD EQUIPMENT SPEEDS

SKATE WHEEL ASSEMBLY

By E. GORDON READER
Vice President & General Manager
Ferguson Machine Corp.
St. Louis, Mo.

PROGRESS can be estimated in a given industry by examining the extent to which standardized equipment is available. A broad market created by a definite need; adequately designed equipment leading to proved results and customer acceptance; availability stemming from a manufacturer's willingness to make items for inventory—these are but a few of the interrelated considerations which lead to the marketing of standard lines of equipment. From another standpoint, availability of standard equipment implies that fundamental technical problems have been definitely mastered. Thus if standardized equipment is available, a given technology must have progressed beyond the new or experimental stage.

If the "availability" test is applied to assembly equipment, it is apparent that significant strides have been made in automatic assembly in the past few years. Several companies have made real progress in standardized automation. This does not mean that inventories of assembly machines are maintained, ready for instant delivery upon order. But methods have been developed which speed delivery and make the final assembly machine available at a price lower than it would be if all parts were manufactured only when ordered. To cite our company practice as an example, indexing mechanisms, machined dials, housings,

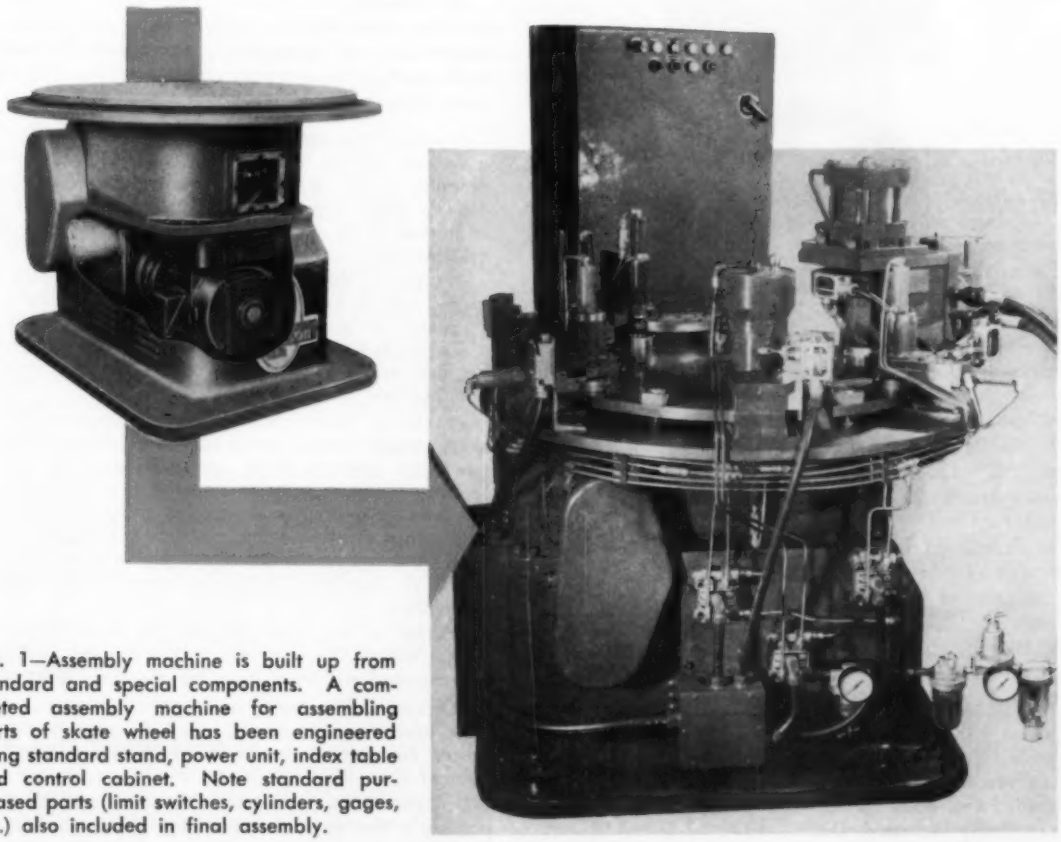


Fig. 1—Assembly machine is built up from standard and special components. A completed assembly machine for assembling parts of skate wheel has been engineered using standard stand, power unit, index table and control cabinet. Note standard purchased parts (limit switches, cylinders, gages, etc.) also included in final assembly.

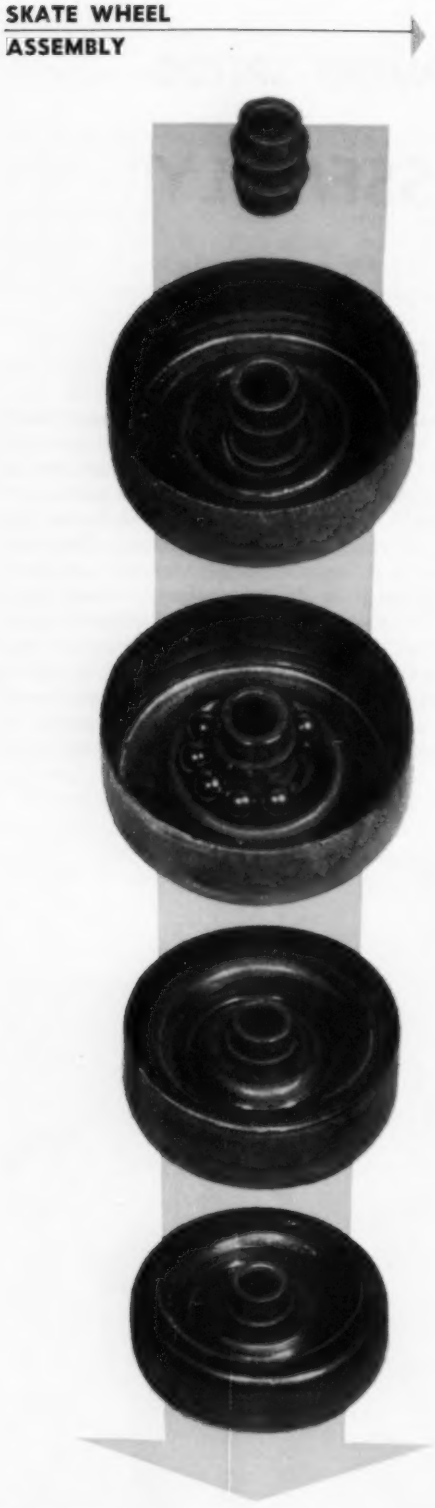


Fig. 2—Steps in assembly leading to completed skate wheel. The axle is placed in nest attached to index table; outer shell is placed over axle; eight balls are fed from hopper; inner web positioned in outer shell; and parts formed into finished wheel by hydraulically actuated die.

stands, control panels, etc. are produced in quantities. Upon receipt of an order for a transfer machine meeting the specifications of the stock items, various components are assembled. Special tooling is developed only if standard components cannot be used.

▶ Typical Problem

A specific case in point is a rotary transfer assembly machine for the automatic assembly of ball bearing roller skate training wheels. The machine, designed and built by Ferguson Machine Corp., was delivered to the Winchester Div. of Olin-Mathieson Chemical Co. The machine base is composed entirely of catalog components carried as stock items, including a high speed precision index table; a packaged power assembly with motor, clutch-brake and gear reducer; stand with drive assembly and electrical control panel, *Fig.* 1.

The index table for this particular application has a 36-inch dial, 12 stops, and a 270-degree indexing period. It includes a roller gear drive indexing mechanism rated for a minimum of 8000 hours operation and an accuracy of 0.0015-inch on the working circle of the dial without auxiliary locating devices. The control panel is of a standard Ferguson design usable with either a standard rotary or in-line assembly base.

As tooled, the machine uses seven stations to position three parts and eight balls, assemble them together, eject the assembly and check the emptied work nest. The sequence of operations, *Fig.* 2, is as follows:

STATION 1: Axles are fed to the work nest through a vertical column, with the bottom axle in the column dropping into a horizontal slide and being positioned directly above the nest. At the proper time the axle is pushed down on the center pin of the nest by a vertical ram.

STATION 2: The outer shell of the wheel, which also forms half of the outer bearing race, is hopper fed through a horizontal chute, the end of which opens into a horizontal slide. The slide positions the piece above the nest and a vertical ram pushes the part into the nest and over the axle.

STATION 3: Balls are stored in a hopper above the nest. Eight vertical tubes feed the balls to a center pin which prevents their continuous feeding. In operation, a cutoff ring is lowered into contact with the nest. Continuous downward pressure raises the ring into a position which restricts the second ball in each tube and raises the center pin to allow the first ball to position itself in the outer race of the assembly in the nest.

STATION 4: The inner web of the wheel forms the second half of the outer race. It is fed and positioned in a manner similar to that for the outer web.

STATION 5: The work nest now contains the complete assembly and moves under a hydraulically actuated die which lowers to form the outer shell in a manner that locks all parts into a single unit.

STATION 6: An air actuated ram raises the inner portion of the work nest, thus lifting the wheel out of

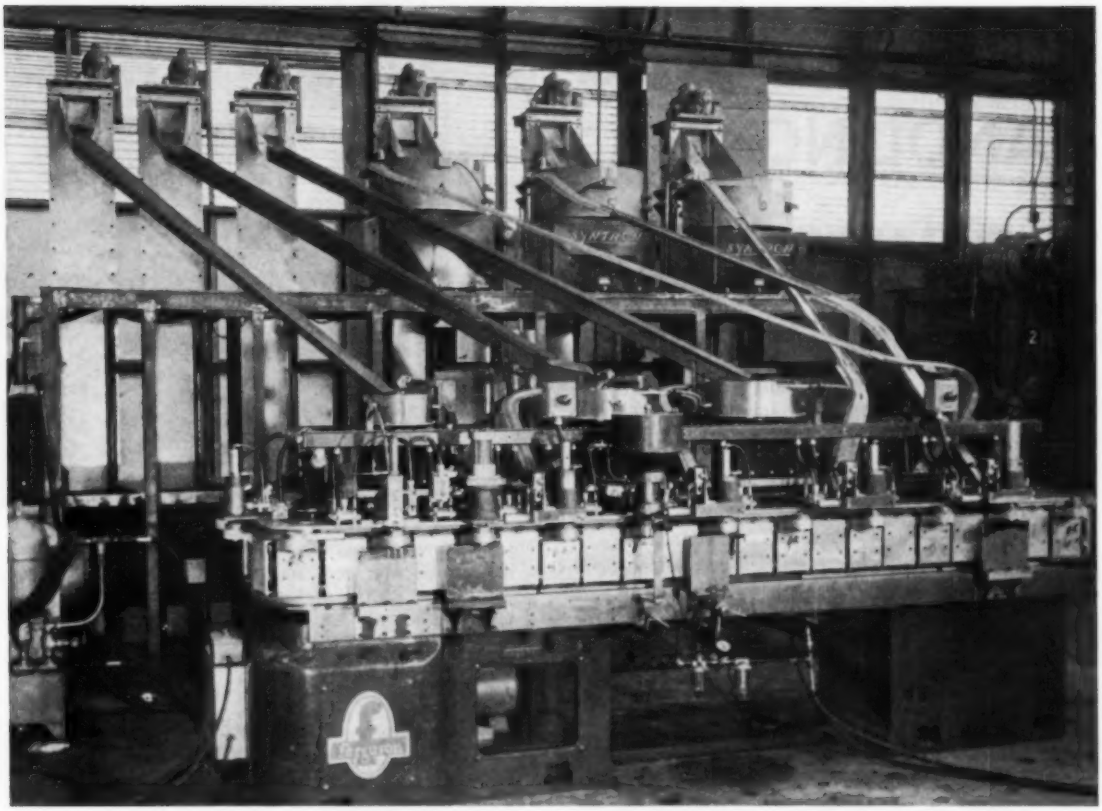


Fig. 3—In-line transfer machine is also used in assembly of skate wheels. The finished wheel consists of eight parts and 20 balls as compared with three parts and eight balls of previous example. For increased rate of production, feed bowls are stocked from elevator-conveyors mounted in rear of assembly machine.

the nest and in line with the removal track. On the next index the wheel enters the track and is retained as the nest snaps back into position.

STATION 7: The nest is checked to assure that the previous assembly has been ejected. A ram with a contour similar to that of the work nest is lowered to within 0.015-inch of contact. In the event an assembly, or any part, remains in the nest, snap action within the ram pushes it from normal position to actuate a limit switch and shut off the machine.

The machine is designed to produce 30 assemblies a minute and needs but one operator. The electrical control panel of the machine contains an interlock system between the indexing and tooling power supply as well as start, stop and jog controls, indicator light and provisions for automatic scanning devices. Either adjustable timer controlled cycle or sequential operation of tooling and transfer may be achieved with the standard control panel.

A Different Solution

A similar problem which necessitated an entirely different assembly machine is shown in *Fig.* 3—a view of the equipment during build-up at Ferguson's plant. In this case an in-line transfer machine is being tooled to assemble skate wheels consisting of eight parts and 20 balls. A standard in-line machine was used as the base since it allowed the placing of more stations and accommodated the more complicated tooling involved. The base unit is slightly over 11 feet long, with product carriers having a 12-inch movement between dwells. As in the case of the rotary transfer machine, besides feeding and locating parts and balls, the machine will also do various forming operations. Because of the rate of production and size of certain parts, feed bowls will be automatically stocked by means of the elevator-conveyors mounted on the superstructure shown behind the assembly machine.

Designers are currently working on standard placing units and workstations suitable for many special purposes because of the obvious advantages to both manufacturers and users. In automatic assembly this includes orienting and placing parts, resistance welding, drilling, tapping, staking, crimping, machining, testing and inspection. As development continues, it is conceivable that certain types of automatic tooling and placing mechanisms will someday be "shelf" items.

HANDLING DEVICES FOR HEAT TREATING

By DONALD BEGGS
Manager of Research and Development
Surface Combustion Corp
Toledo, Ohio

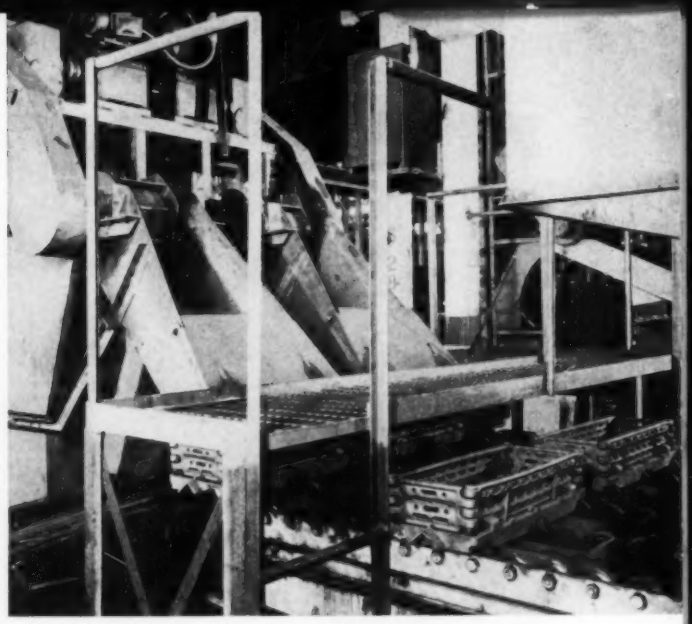


Fig. 1—View of station at which baskets are automatically loaded with parts for trip through annealing furnace. After parts are dumped at discharge end, empty baskets are returned by a conveyor.

DURING the past 25 years, automation of heat treating has developed from the mechanized batch furnace to the automatic continuous furnace, and more recently to the completely automatic heat treat line as an integral part of an automatic production line. In order to design an automated heat treat line, the engineer must consider the devices that are to be incorporated. An individual device in itself is seldom spectacular. However, the total effect that can be achieved by the application of a multiplicity of such devices in an automatic heat treating unit is often quite dramatic.

Devices for Work Loading

The physical movement of workpieces being processed is an important consideration in the design of automated heat treating equipment. Conveying devices are used in various combinations to load, push, pull, raise, lower and unload workpieces for heat treating. Movement of parts in the charging operation can be accomplished in a basket, *Fig.* 1, tray or other fixture, or by direct piece-to-piece contact of the parts being heated. Work processed in heavier loads and longer furnaces that do not utilize controlled atmospheres, can be pushed through the heating chamber on roller rails that extend beyond the charge and discharge doors. This arrangement, with a pusher mechanism under the roller rails, permits work tray access from all directions and movement of the work straight through the furnace.

The drawings in *Fig.* 2*a* illustrate some of the more conventional devices employed to automatically charge heat treating furnaces. They include

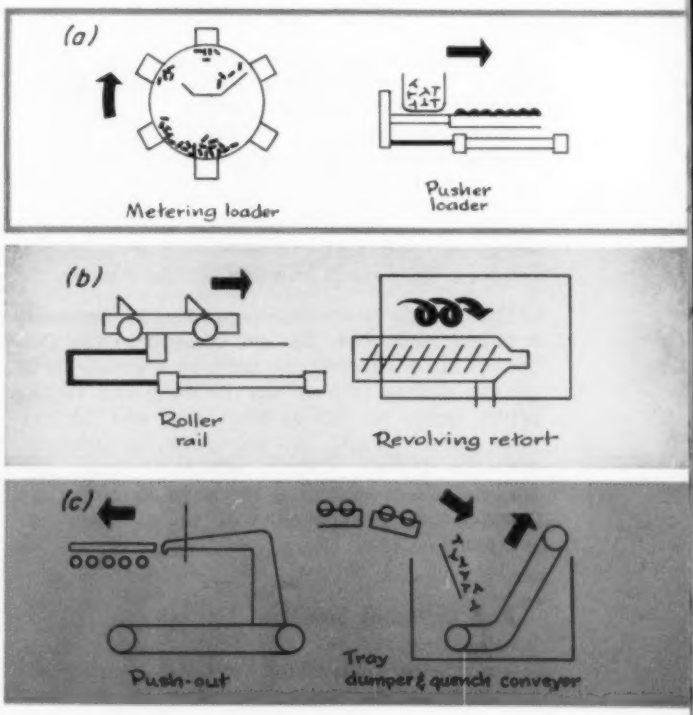


Fig. 2—Sketches illustrate some common devices used to automatically perform functions in heat treating: *(a)* Loading, *(b)* conveying through furnace, and *(c)* discharging and transferring to subsequent operations.

metering loaders, pusher loaders, skip car loaders, pusher chain loaders, hopper loaders, and end heating loaders. The selection of a particular type of automatic mechanism for a specific application is normally dictated by the time cycle of the process, plus the size, shape, weight, and volume per hour of parts the furnace will be expected to accommodate.

Automatic mechanisms have been designed and used for accurately feeding small parts to flat surface conveyor belts under a timed cycle. These mechanisms are usually of the oscillating or drum type designs, although mechanisms with continuous flighted belts are often used for automatically feeding large parts. Metering devices usually operate on the basic principle of a beam scale and meter the parts according to an adjustable weight setting on the scale beam.

Conveying Mechanisms

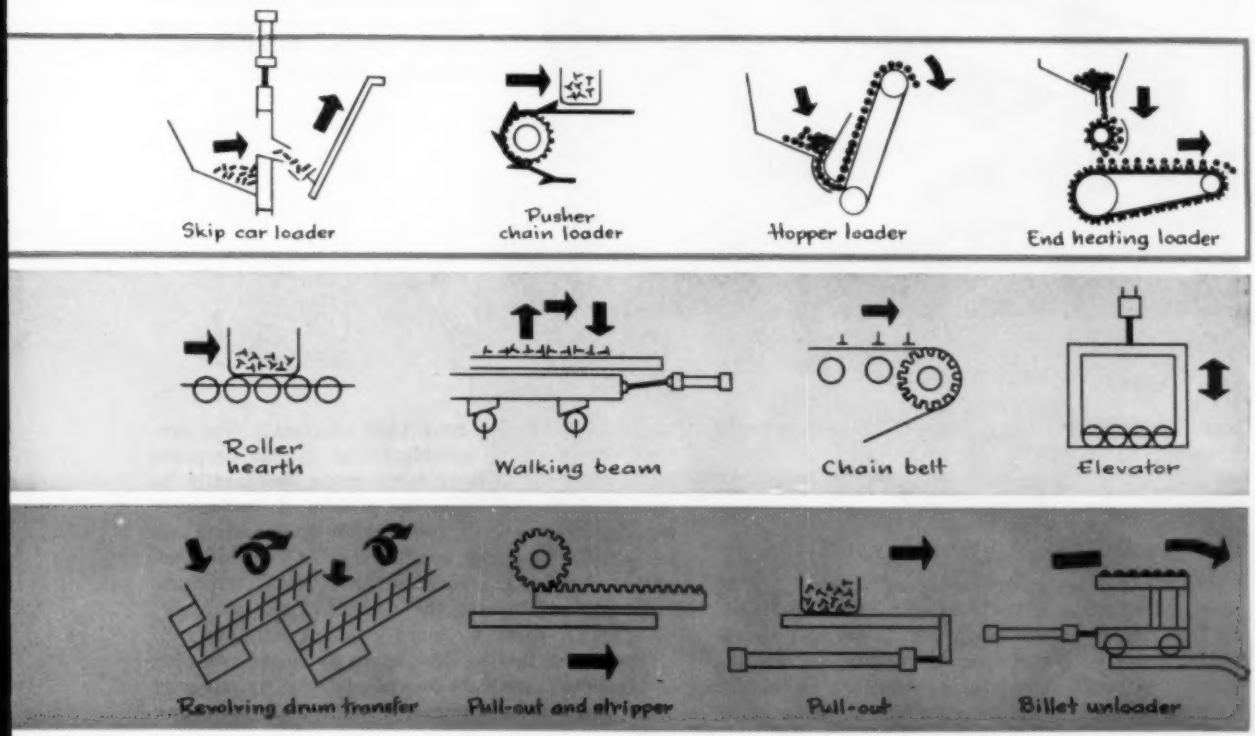
Roller rail, roller hearth, chain belt, revolving retort, walking beam, and elevator arrangements, shown in *Fig. 2b*, are typical methods of conveying work through the heating chamber or zones of the furnace. Weight, size, and shape of parts to be conveyed are again factors in the proper selection of the conveying mechanism. Also, maximum furnace operating temperature will dictate the conveyor design and type of metal used in its construction which must economically withstand the deteriorating effects of thermal exposure.

In the application of push-pull mechanisms for automatic charging and discharging of a batch type furnace, the trays or baskets used are linked together. The reciprocating action can be interlocked with the furnace door for fully automatic operation. A motor driven chain can actuate an arm that pushes the load forward into the heating chamber at the beginning of the cycle and withdraws the work by hooking the tray at the end of the cycle.

Continuous, straight-through, double-end furnaces may be equipped with a pusher mechanism on the charge end. Discharge can be accomplished by gravity, or by the charging type of mechanism operating in reverse. Two basic types of mechanisms are commonly employed: mechanical linkages and pneumatic or hydraulic cylinders. User preference often determines which type of mechanism is installed. In the mechanical mechanism, a motor driven reversible chain actuates a dog that pushes against the edge of the last tray during forward movement of the chain. A variable speed drive permits flexibility of cycle. Operation can be fully automatic or semiautomatic. Where pneumatic cylinders are used, a rocker arm arrangement is often employed to actuate a dog located under the roller rails of the charger. Where uniformly smooth forward movement of work trays is required, hydraulic cylinders or mechanical screw pushers are commonly used.

Discharging and Transferring

Schematic drawings of devices often employed to automatically discharge and transfer work subsequent to heat treatment are depicted in *Fig. 2c*.



HANDLING DEVICES FOR HEAT TREATING

An automatic dumping mechanism at the discharge end of the hardening furnace may be so devised as to pull the heating trays from within the heating chamber, through the open door, and position the trays upon an automatic turnover type dumping mechanism. After the trays have been withdrawn from the furnace the discharge door is then automatically closed. The dumping mechanism clamps the trays automatically and rotates them through 180 degrees to ensure the dumping of all the parts from the tray into the quenching oil.

The revolving drum transfer device shown in *Fig.* 3 is similar in principle to a revolving retort mechanism used to convey parts through the furnace. Both mechanisms utilize the screw principle. In this transfer application the drum is perforated and used in an inclined position for removing parts from the oil quench.

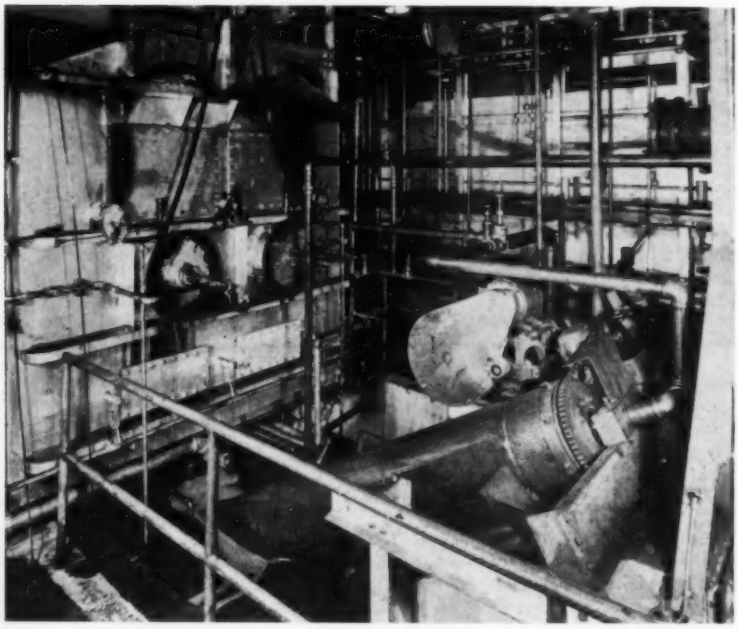


Fig. 3—Perforated drum shown is rotated to elevate parts from quench bath and transfer them to succeeding operation.

Control Devices

Obviously, the effectiveness of automation is also dependent upon the control devices employed. In heat treatment, use of controls is especially vital to the quality of the finished product. For example, without automatic pyrometer controllers to regulate the heating processes, or time cycle controls to establish heating times, the automatic flow of work through the furnace would be of little value.

The dewpoint method of carbon potential determination is widely accepted by heat treaters, as well as furnace equipment manufacturers. In our Surface Combustion Corp. laboratory, we developed a completely automatic unit known as the Autocarb. The Autocarb system employs a mechanism that automatically controls the dewpoint of a gas atmosphere at any desired value. This control may be exercised at the gas generator or in the furnace heating chamber, with resulting control of carbon potential in the heat treating atmosphere in the furnace. The unit provides automatic compensation for varying carbon demand by the work being treated. Consequent high uniformity from piece to piece makes tighter specifications possible.

Design of automatic handling devices presents little or no problem after product standardization and control devices have been adopted. The preliminary planning considerations in the proposed automation of heat treating must necessarily be well conceived to avoid the pitfalls of uneconomic automation; however, the decision to automate can be justified for any combination of reasons such as the following: Increase production; duplicate results by minimizing the element of human error; reduce unit costs by more efficient handling; increase use of limited floor space by closer grouping of furnaces; eliminate loss of material by reducing scrap and rejects; combine a number of operations.

HYDRAULIC MACHINE SPEEDS
TUBE KNURLING

Replacement of job shop or toolroom type equipment in large volume manufacturing operations is the natural domain of automatic machinery. In this example, knurling, a traditional lathe operation, has gone automatic as applied by one manufacturer of cookware.

By **V. N. HANSFORD,** President, Morley Machinery Corp., Rochester, N. Y.

KNURLING, usually thought of as a relatively slow lathe operation, has been changed to a high speed production operation at the Rome Mfg. Div. of Revere Copper and Brass Co. Engineers there, in a continuing search for improvements to existing manufacturing methods, recently focused their attention on the knurling operation which is applied to stainless steel tubing for skillet and saucepan handles for their line of commercial cookware. The result has been the development of an automatic, hydraulically powered knurling machine on which parts are

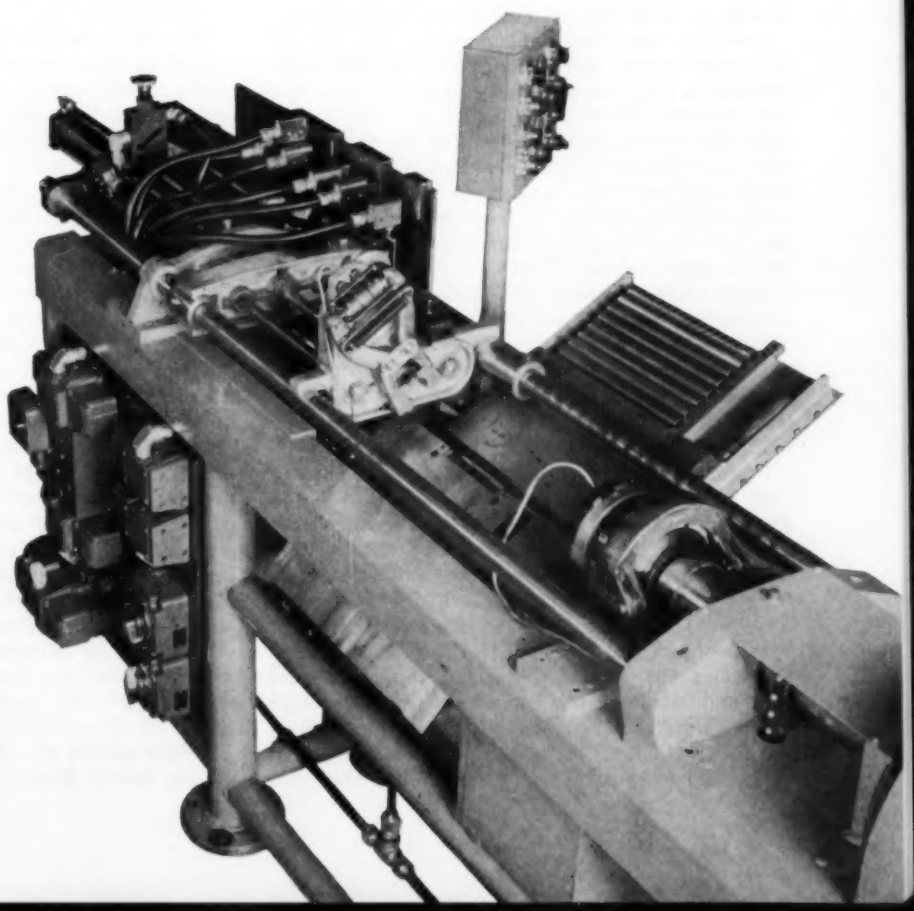
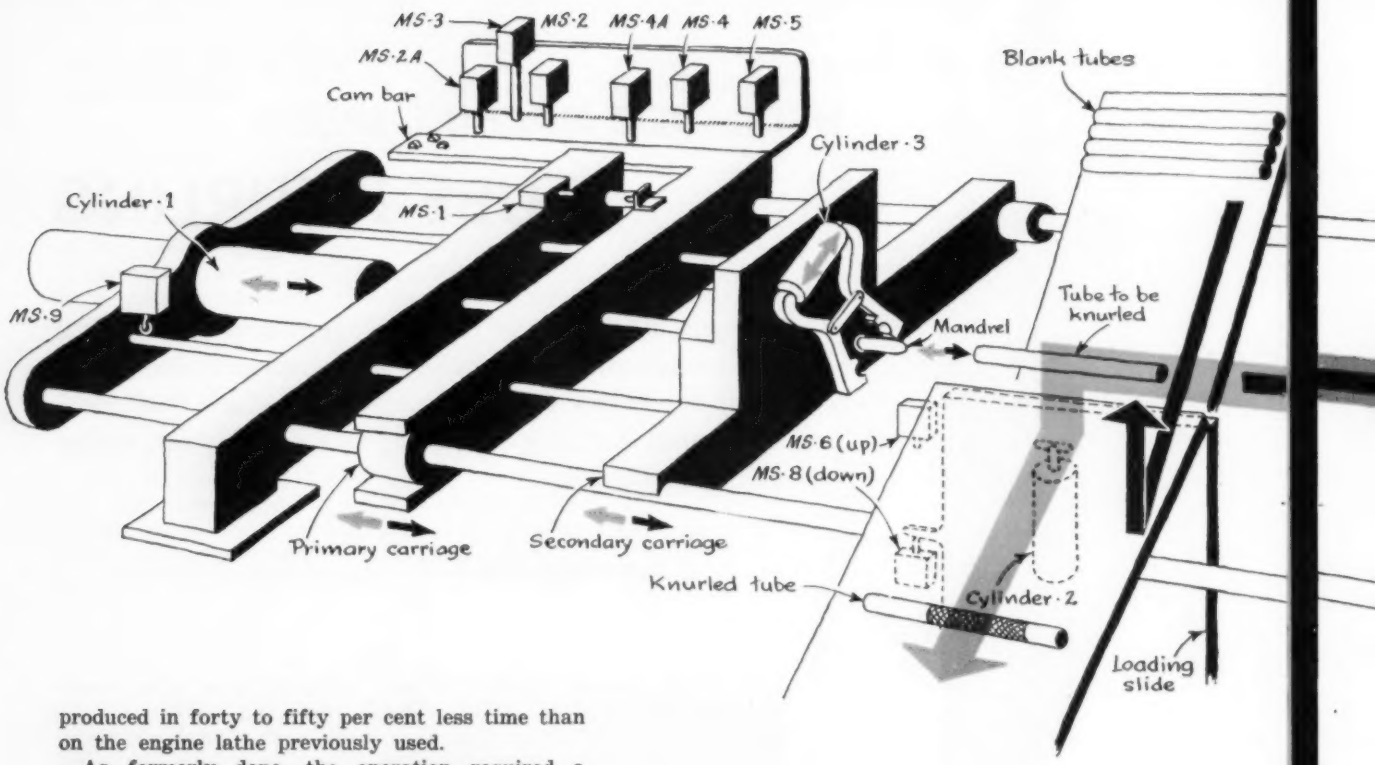


Fig. 1—This closeup shows the main operating elements of the hydraulically powered machine for automatically knurling thin-walled stainless steel tubes. Parts to be knurled have been loaded in the magazine on right side of the machine.



produced in forty to fifty per cent less time than on the engine lathe previously used.

As formerly done, the operation required a skilled lathe hand, since knurling, particularly of stainless steel, is by no means the simplest form of lathe work. Procedure was to force fit a steel mandrel in the thin-walled (0.050-inch) tubing, chuck the assembly in a lathe, and carefully start and traverse the knurling rolls across the work, coming to a distinct stop at the end of the knurl.

Realizing the time consuming aspects of the above procedure, Rome engineers initiated an investigation into the possibility of acquiring a special machine which would knurl the tubes automatically. Their interest resulted in the design and construction of such a machine by Morley Machinery Corp. The machine is shown in *Fig.* 1. It functions automatically, and one unskilled operator need only keep the magazine full and inspect the finished knurled tubes.

Since their complete line of cookware includes a variety of sizes, Rome engineers had to specify that the machine accommodate tubing 6 to 17 inches long and between ¾ and 1⅛ inch outside diameter. Also, the starting position and total length of the knurled section had to be adjustable within limits determined by the product.

Preliminary tests by Morley engineers indicated that knurling should be accomplished by the following procedure: (1) Insert a steel mandrel into the tubing under a light press fit; (2) position the work inside the die head in the proper location for start of the knurl; (3) close the die head under force; (4) rotate the die head slowly for about two revolutions to establish tracking of the knurling rolls; (5) speed up the rotation of the die head and simultaneously advance the work through the die head, with cutting oil liberally applied to the rolls; (6) stop the feed at the selected length of knurled section; (7) stop the spindle and open the die head; and (8) retract the mandrel, stripping the work from it.

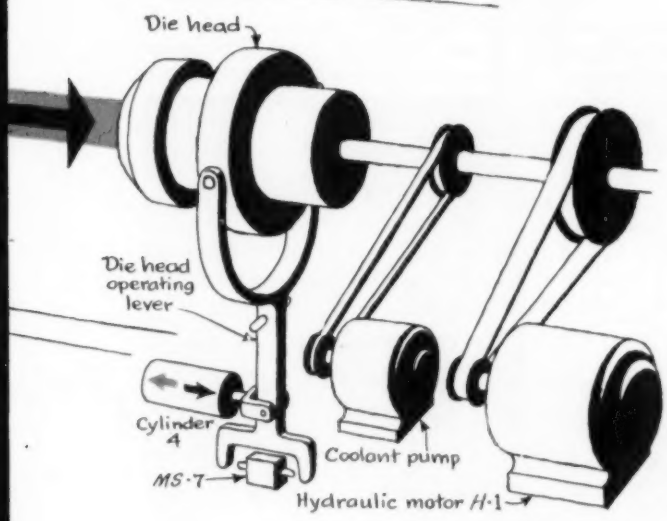
▶ Beginning the Cycle

To start operation of the machine, the operator loads the magazine with tubes, starts the hydraulic pump motor and energizes the control circuit. By reference to the schematic machine diagram, electrical control schematic, hydraulic graphical diagram, and motion sequence chart shown in *Figs.* 2, 3, 4 and 5, the control and operation of the machine may be followed.

Assuming that the loading slide is in its uppermost position so that the first tube to be knurled is aligned with the headstock, and that rotary switches *RS*-1 and *RS*-2 are in *AUTO* and *SEMIAUTO* position respectively, action proceeds in the following manner and sequence: Momentarily pushing *PB*-1 energizes and holds relay *R*-1. Normally open contacts of *R*-1 then close and energize the *A* and *C* coils of solenoid valve *SV*-1. This valve opens full and admits oil to cylinder *CYL*-1, causing rapid advance of the primary carriage toward the headstock. A hardened, chrome-plated steel mandrel on the primary carriage is thus forced into the tube. Resistance against movement of the tube is provided by a shoulder at the front end of the loading slide.

Attached to the primary carriage, and traveling with it, is a cam bar which contains three dogs designated front, rear, and toggle. The rapid advance of the primary carriage is interrupted when the rear dog on the moving cam bar contacts snap-action switch *MS*-2*A* which is fixed to the frame

Fig. 2—Sketch showing mechanical details of the automatic tube knurling machine.



of the machine. Tripping of this switch disconnects coil *C* on solenoid valve *SV*-1. With only coil *A* energized, the flow of oil to *CYL*-1 is diminished, and the movement of the primary carriage changes to coarse feed. The purpose of this slowing action is to facilitate accurate stopping of the carriage when the mandrel becomes fully inserted in the tube. The coarse feed rate is determined by a dial adjustment on *SV*-1.

Forward motion of the primary carriage continues at coarse feed until the front dog trips switch *MS*-2, breaking the *R*-1 holding circuit and de-energizing coil *A* of *SV*-1. The primary carriage then stops. The mandrel has been fully inserted in the tube.

When *MS*-2 is tripped, its normally open contact closes and energizes the coil of relay *R*-2. *R*-2 in turn applies voltage across coil *B* in solenoid valve *SV*-1 and the carriage is caused to retract rapidly away from the headstock at a rate determined by the setting of flow control valve *FC*-1 in series with *CYL*-1. Rearward movement of the carriage continues for about an inch of travel, whereupon the toggle dog on the cam bar operates switch *MS*-3. It should be noted that the construction of the toggle dog is such that it actuates the switch only on reverse motion of the carriage.

When *MS*-3 trips, it breaks the *R*-2 holding circuit, disconnecting coil *B* in *SV*-1 and stopping the carriage. The purpose of the slight rearward motion is to free the loading slide of pressure from *CYL*-1 so that the slide can be dropped.

Simultaneously with the above action, a normally open contact of *MS*-3 closes to energize the coil of relay *R*-3. This occurrence, through normally open contacts on *R*-3, also energizes the coils of relays *R*-3*A* and *R*-3*B*. At this time, a normally closed contact on *R*-3*A* de-energizes solenoid valve *SV*-2 and the loading slide lowers under hydraulic action by cylinder *CYL*-2. Relay *R*-3*A* is now held in and will remain so until the cycle is complete and the front dog on the cam bar trips switch *MS*-1.

When the loading slide reaches its bottom position a switch, *MS*-8, in series with contacts on *R*-3*B*, is tripped. Coils *A* and *C* of *SV*-1 are reconnected and rapid forward motion of the primary carriage resumes.

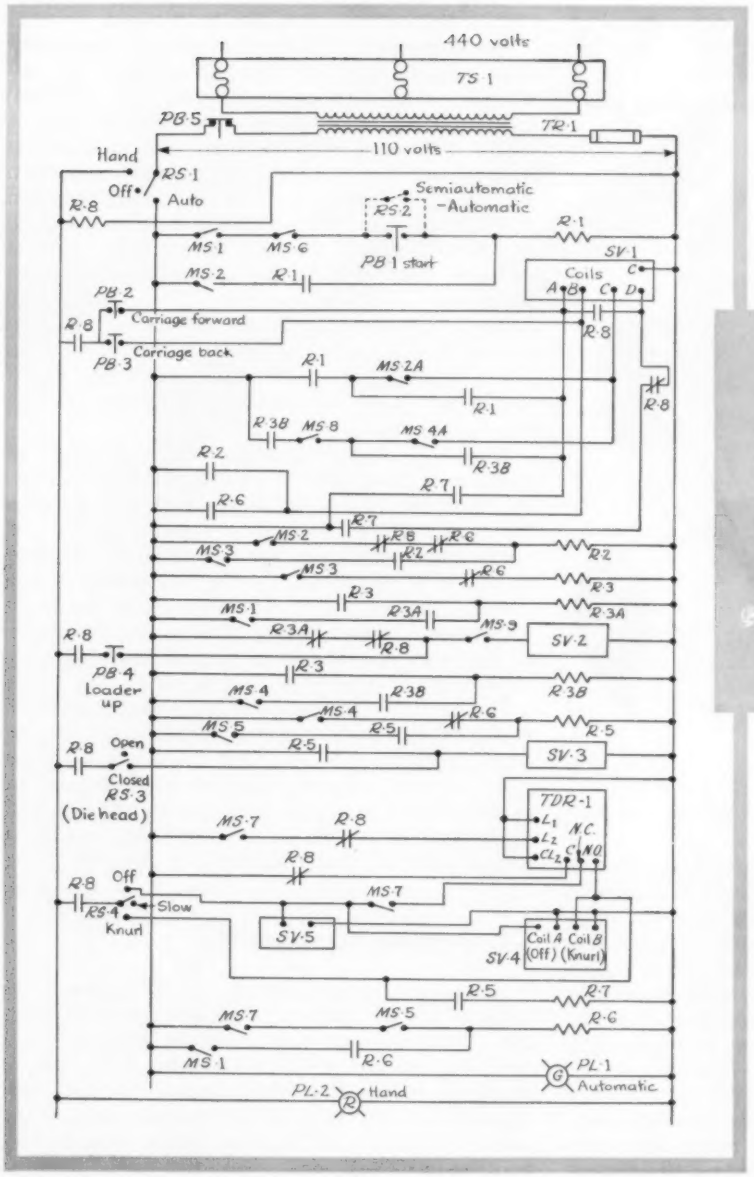
It again becomes necessary to slow the speed of traverse of the primary carriage, and this is effected when the rear dog on the cam bar actuates switch *MS*-4*A*. By this action, coil *C* on *SV*-1 is again disconnected and the flow of hydraulic fluid to *CYL*-1 is restricted. Coarse feed motion of the carriage continues in a direction toward the headstock until the next switch, *MS*-4, under the action of the rear cam dog, trips and de-energizes relay *R*-3*B* and coil *A* in *SV*-1. The carriage then stops.

To this point, the action of the primary carriage has been as follows: it has advanced rapidly toward the headstock, inserting the mandrel in the tube, slowed, stopped, reversed and stopped to permit retraction of the loading slide, and resumed rapid forward motion until slowed and stopped in position for starting the knurl on the tube.

▸ Clamping and Knurling

A normally open contact on *MS*-4 closes on tripping by the rear cam dog and energizes relay *R*-5. This relay in turn energizes solenoid valve *SV*-3 to actuate *CYL*-3. Cylinder *CYL*-3 is a standard automotive wheel brake cylinder, and its double action closes both halves of a split clamp about the outside of the tube. When pressure has built up in *CYL*-3, sequencing valve *SEV*-1 permits flow also to *CYL*-4 and the die head closes to bring the knurling tools in contact with the work. These actions are very rapid. The tube clamp assembly is mounted on an independent secondary carriage, and actuation of the clamping jaws coincides with physical contact between the two carriages. When the primary carriage is moved toward the headstock, the secondary carriage, now contacting it, is pushed along with it. Joining of the two carriages is made positive at the time of contacting by the mechanical latching in place of a toggle bar.

When the die head closes on the work, *MS*-7 is tripped and two actions occur: Time delay relay *TDR*-1 is energized, and the spindle headstock drive starts to turn at slow speed. Previously, hydraulic motor *H*-1 which rotates the spindle headstock had been stopped because venting valve *SV*-5 and coil *A* (*OFF* position) of *SV*-4 were



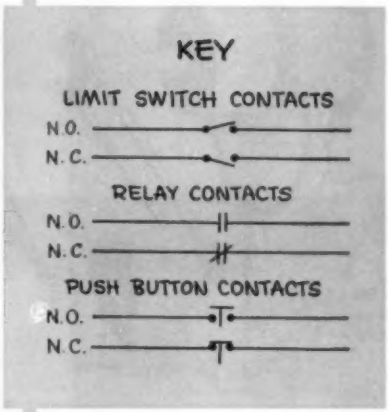


Fig. 3—Control circuit schematic diagram. A transformer in the circuit reduces the 440-volt ac line voltage to 110-volt ac for application to the controls.

energized. Tripping of *MS*-7 de-energizes these controls so that throttling valve *TV*-1 is in play to govern the speed of the head.

The function of *TDR*-1 is to delay the start of high speed rotation of the headstock spindle until the knurling tools have penetrated to full depth at slow speed and begun tracking on the surface of the tube. When this control times out, a normally open contact closes and energizes coil *B* in *SV*-4. Speed control is then shifted to throttling valve *TV*-2 and high speed rotation of the spindle ensues.

Also connected to the spindle shaft is a coolant pump which directs a stream of cutting oil on the knurling tools while the spindle is rotating. A catch basin is located beneath the die head.

Closing of the external contact of *TDR*-1 after the preset time interval also energizes relay *R*-7 through the closed contacts of *R*-5. When *R*-7 is energized, it in turn energizes coils *A* and *D* in *SV*-1 and this action causes both carriages to advance toward the headstock at fine feed for knurling. Another dial on *SV*-1 controls the fine feed rate. This motion continues until *MS*-5 mounted on the machine frame is tripped by the cam bar. By this action, *R*-5 is de-energized, the feed is stopped by *SV*-1, *CYL*-3 and *CYL*-4 are actuated by *SV*-3 and the tube clamp and die head open. Since a definite interval of time is required for *CYL*-4 to operate the die opening lever and restore *MS*-7 to its normal position, the spindle continues to rotate a short time after the carriage

stops advancing. This feature provides a clean pattern at the end of the knurl. The tubing has now been knurled and is ready to be stripped from the mandrel.

▶ Unloading the Part

When *MS*-5 is tripped by the cam bar, its normally open contact closes and when the die head opens, the *MS*-7 normally closed contact closes. These two switches complete a circuit to energize *R*-6. A normally open contact of *R*-6 energizes coil *B* in *SV*-1 and the carriage again moves rapidly away from the headstock. *R*-6 is held in until the cycle is completed and the front dog trips switch *MS*-1, de-energizing all the coils in *SV*-1.

As the carriage continues its move away from the headstock, the front dog on the cam bar will trip switches *MS*-4, *MS*-3 and *MS*-2 in turn as it rides under them. To eliminate interaction, normally closed contacts of *R*-6 have been placed in series with the normally open contacts of these switches so as to deactivate them during the return stroke of the primary carriage.

When the linked primary and secondary carriages have retracted a short distance, stop rods on the secondary carriage, which project back through the primary carriage, bottom on the machine frame at the rear of the machine. The toggle connection between the carriages breaks away and only the primary carriage continues to retract. A bushing in the center of the secondary carriage, which has clearance for passage of the mandrel but not for the knurled tube, strips the part. The finished tube falls straight down into a chute and then to a pan.

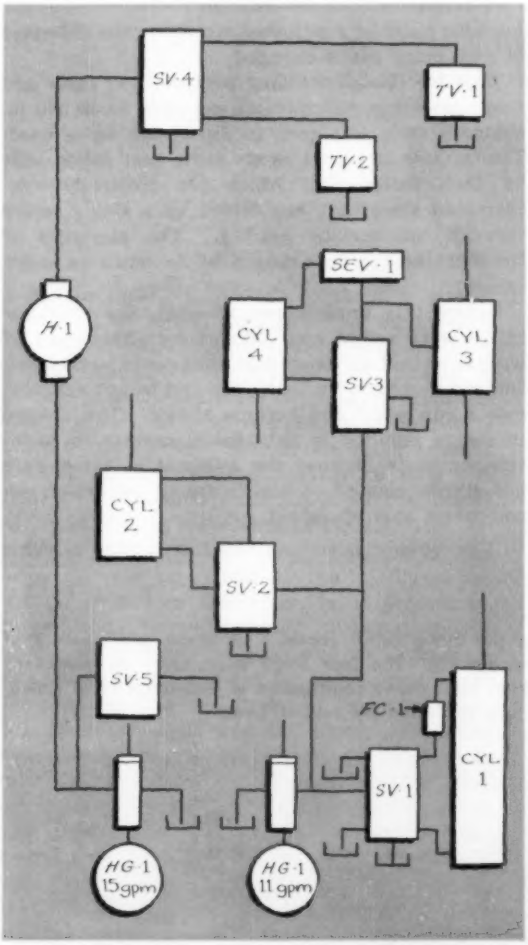


Fig. 4—Hydraulic circuit graphical diagram. Hydraulic generator *HG*-1 includes two separate pumps shaft-mounted on one 20-hp electric motor. This assembly is part of a separate packaged power unit which serves the machine.

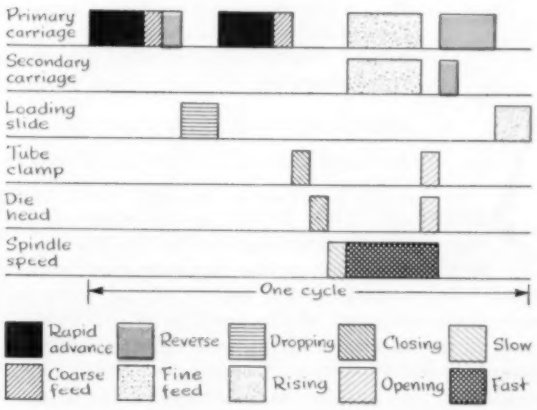


Fig. 5—Chart shows the sequence of actions of the various machine elements during one cycle of the automatic knurling machine.

When the primary carriage comes to rest, the loading slide rises, presents another tube from the magazine, and the machine stops. Re-initiation of the cycle requires another momentary contacting of pushbutton *PB*-1. If both *RS*-1 and *RS*-2 are placed in *AUTO* position, the cycle repeats automatically. When switch *RS*-1 is positioned on *HAND*, the individual operations described above are controlled by pushbuttons *PB*-2 through *PB*-4 and rotary switches *RS*-3 and *RS*-4. This mode of operation is most used for setting up the machine and changing over for different tube sizes.

The development of machines such as the one described here exemplifies the continuing effort being expended in the direction of economical production of goods of all kinds. Of more general interest and value are the broad possibilities for application of some of the design principles of this machine to automatic machines in other industries and for other products. It is by cross-fertilization of ideas from many sources that the fastest progress toward automation in all fields will be realized.

MACHINE MOVES FOR SETUP CHANGES

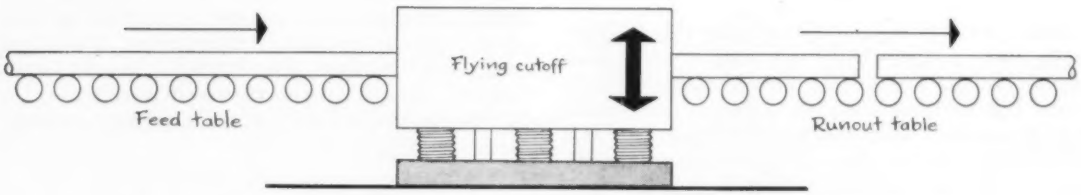


Fig. 1—Illustration of a production operation where it is easier to reposition a machine than to adjust related conveying means for changes in product size. Pipe is cut into desired lengths by flying cutoff machine whose height is adjusted to cut pipe of different diameters.

BRINGING THE WORK to the machine, in the exact position required by the machine, is the common practice in production operations. But sometimes the nature of the work is such that movement of the machine is preferable. Such is the case with flying pipe cutoff machines manufactured by Wm. K. Stamets Co. Continuous lengths of pipe are fed on a conveyor table to the flying cutoff and the cut lengths move away on a table at the same level as the feed table, *Fig.* 1. Because the pipe must center in the cutoff machine, the relative heights of the conveyor tables and the machine must be readjusted whenever the diameter of pipe being cut is changed.

To solve this positioning problem and raise and lower machines which weigh as much as 85,000 lb, subbases such as shown in *Fig.* 2 are being used. The subbase incorporates six worm gear jacks, built by Duff-Norton Co., which are positively synchronized since they are driven by a single motor through appropriate gearing. The elevation of the machine can be changed by as much as seven inches.

Before this system was adopted, the conveyor tables were raised and lowered by adjustment of wedges so that different pipe sizes could be handled. But the wedges were unwieldly and wedge arrangements can wear and become shaky. The change in design resulted in substantial savings in maintenance costs because the adjustable tables were not sturdy enough to absorb rough use which accompanies this operation.

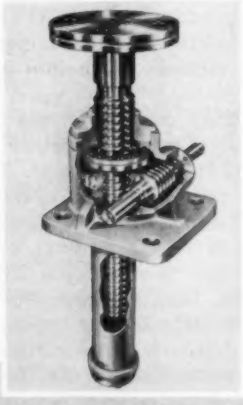
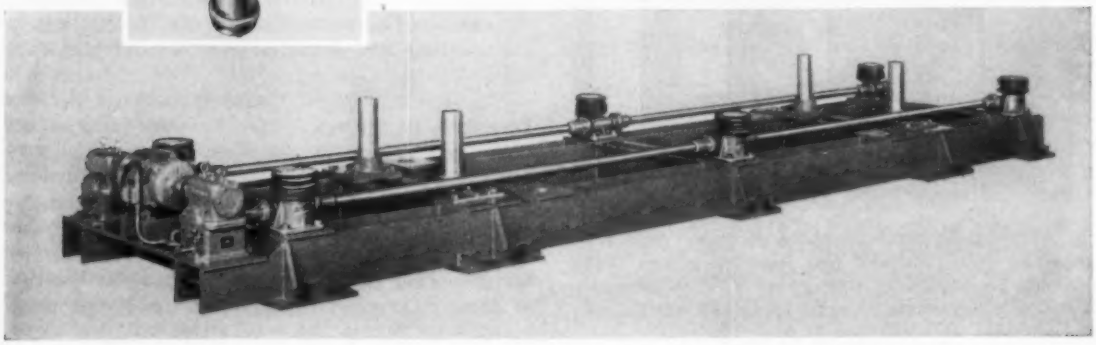
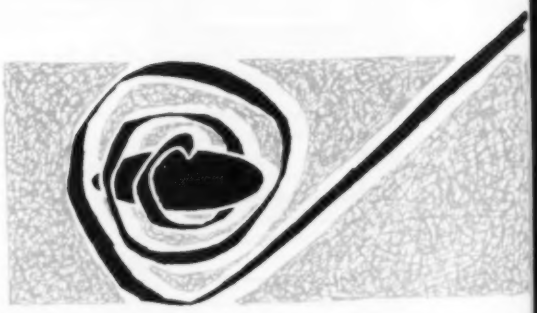


Fig. 2—Subbase for the flying cutoff contains six worm gear jacks that raise and lower the machine. The four large posts serve as guides to absorb any side thrust. Inset shows construction of individual jacks which, in this application, are protected by rubber boots.



RANDOM ACCESS TO DATA



IMPROVES INFORMATION PROCESSING

Various types of equipment can aid the modern manager in obtaining current facts needed for plant operating decisions. One of the most important types is an electronic data storage device which permits not only rapid access to stored information but also access as determined by need. This article discusses such equipment and by varying the emphasis, the equipment discussions also become a vehicle to illustrate certain aspects related to the general theme—random access memories.

MANAGEMENT, today, expends a sizable amount of money and effort in an attempt to have their data handling operations keep pace with production operations. All phases of a business activity are affected, ranging from the recurring transactions in the change of status of payrolls, billings, orders, inventories, machine loads and schedules to periodic summaries of vital statistical data. Management might decry the factors which have led to expanding administrative requirements, but it cannot deny that timely and accurate information is vital to the intelligent operation of a modern enterprise, be it processing, transportation, manufacturing, distribution, or rendering of services. Considered as a management problem, achieving the optimum use of data can be divided into two parts: The timely collection of information, and the timely processing of available information. This discussion is concerned with the use of equipment for the latter phase—which typically centers about the handling of individual data transactions related in some manner to previously stored data.

Stored data can be retrieved by one of two general methods: By a scanning type operation involving an item by item search until the desired data is found, or by direct reference to the desired data because it has been so organized, compartmented or classified that unwanted items can be ignored in the search. Data storage devices which permit direct and rapid access to individual items stored in a large mass are referred to as random access memories.

The term "random access" can be used to describe the method of referral to a data processing machine's internal memory—that memory which provides storage for a machine's instructions, constant information associated with the machine's operation, and work areas which the machine can use in carrying out its instructions. However, the use of the term is conventionally directed to a second category of machine storage means—external memories.

The external memory of a data processing machine is the depository of those records and data connected with a business which have been reduced to a form understandable to the machine. Capacities of internal memories vary from a few hundred characters to several hundred thousand characters. External memories have capacities that are measured in the millions of characters. External memories are used to store information for such records as billing, inventory, sales analysis, payroll, labor distribution, production control, etc. The operation of an acceptable external memory is characterized by high volume storage capacity at reasonable cost. Since cost can be related to a unit of information handled, economical handling of large volumes of data requires short access-time to the data and rapid handling or reading of the desired information. Equipment which makes economic random access available to general data

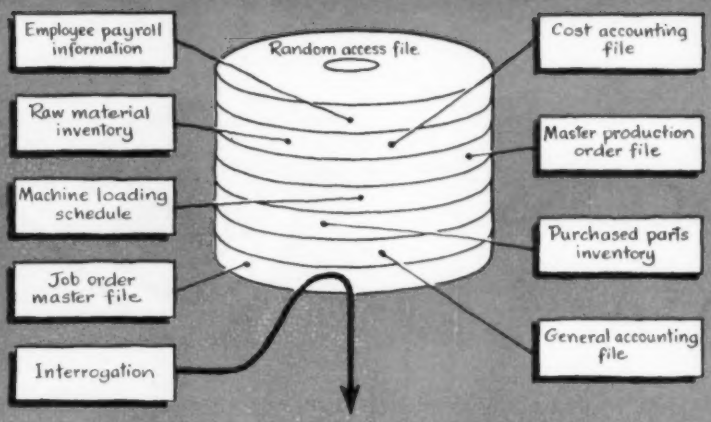


Fig. 1—A random access file containing the indicated data might be interrogated as to status of any record. For a given transaction, all related records are adjusted automatically in accordance with an established program.

Order number	Production number	Status		Quantity ordered	Estimated cost	To date		Estimated completion date
		Department	Machine			Quantity	Actual cost	
15678	621359	37	14	900	15,300.00	350	5775.00	9·17·57

processing requirements has only recently been introduced.

The following discussions deal with random access equipment manufactured by several companies—the use of magnetic disks and tapes is covered. Acceptance by industry of magnetic devices for storage of important business data is built upon experience gained from the use of magnetic tape on reels. Along with punched cards and tapes, magnetic tape has been a favored storage form. Magnetic media possess a number of distinct advantages when compared to nonmagnetic forms: Permissible recording densities result in large volumes of data per size of devices; data can be erased if desired but will not be lost through such accidents as power failure; tests have indicated that normal use does not significantly affect information content; and rapid manipulation possible with magnetic devices more nearly approaches the computational speed of data handling equipment.

Prior to the introduction of the devices discussed in this article, the major disadvantage to practical processing of large quantities of data stored on a magnetic medium was the problem of random access. Data stored on tape in a reel form cannot be manipulated even under ideal conditions at a speed which makes random access economical. The limitation of access can be mitigated if quantities of data requiring similar handling are collected, sorted and processed after a sufficient volume is available. This procedure is the basis for many highly successful data processing installations. If such a system is used, delay in the preparation of records, reports and summaries must be tolerated.

There is a very broad area of application, however, where electronic data processing can be justified only, if, within the bounds of economy, it results in readily available up-to-date information. The availability of up-to-date information is influenced by many factors including the type and source of original data, time and place of occurrence, type of recording system, frequency of changes, etc., but from a practical standpoint, it is apparent that random access to stored data is one of the most important considerations.

Fig. 1 illustrates a company's idea of what random access equipment might mean to a job shop. How many managers are there who would not like to be able to push a button at any time to obtain current statements of such information as inventory levels or cost summaries?

I B M's RAMAC

MEMORY AS PART OF A SYSTEM

TO A COMPANY as intimately familiar with industry's data processing problems as is the International Business Machines Corp., it has long been apparent that random access to data files was needed. In the days when business record requirements were simple and informal, data processing could immediately follow transactions. The result was an in-line processing operation and current information. With increase in the volume of data handled, the in-line approach gave way to considerations of economy in data handling and the concept of batching was created. Even with the aid of much of the electronic equipment available today, data must be accumulated in batches for economical processing. This requirement has evolved to the point where batch accumulation time in certain areas exceeds process time. Special purpose equipment can alleviate

particular problems, but for general applications, random access is required to eliminate batch operations and to return business data processing to an in-line operation, *Fig.* 2.

Following research at their San Jose laboratory, in 1955 the company announced an experimental random access file built around a magnetic disk memory. Subsequent field tests followed and in the fall of 1956, the formal announcement of 305 RAMAC and 650 RAMAC was made. The first is a self-contained accounting machine built around a magnetic disk storage unit. The second is an addition of a random access memory to the existing IBM 650 data processing system.

The memory device of the 305 RAMAC is a vertical stack of 50 magnetic disks 24 inches in diameter. Both sides of a disk are used for recording data. Each disk face can be divided into 100 recording tracks, and each track will hold five 100-character records. The total storage capacity of one such stack is 5 million alphanumerical characters. The entire stack rotates at 1200 rpm, and access to the records is by means of an arm which moves vertically and horizontally under electronic control. Access to the file varies between a maximum of 0.8 seconds to a minimum of 0.15 seconds.[1]

Physically there are four distinct units within a 305 RAMAC system. At the right of *Fig.* 3 is the console which contains a card reader, switches and lights for control of the machine, and a keyboard and printer for file inquiry and system test. Cards can be read by the reader at the rate of 125 per minute simultaneously with occurrence of other programed operations. The inquiry system allows selection and typing of records from the file independently of normal processing. In the center of the photograph is the main frame which includes the magnetic disk random access file, processing unit and power supply. The processing unit contains magnetic cores, electronic circuitry and a magnetic drum. It is in this section that the machine program is stored, information rearranged, and mathematical and logical operations performed.

In the left of the picture is the output center which consists of a card punch and printer. The card output punches data into cards at speeds up to 100 cards per minute; the printer prepares reports at speeds up to 80 lines per minute. The speeds of the various units within the system were set to achieve a balance in the time that each unit spends upon a given transaction. The printer was the first unit chosen and the speeds in the remainder of the system were balanced to this. In a given operation, the overall system speed will be limited by one of the unit speeds. For instance, in loading the file from cards, the machine will normally be card-feed limited, and in printing a typical billing job would probably be printer-limited.

▶ Control System

The design of the machine system centers around the method chosen for control. Generally speaking, flexible machine systems are based on one of two techniques of control—a fully stored program or a fully wired control panel program. After investigation neither of the two systems was found to be ideally suited to the requirements of the machine as envisioned and the final control system is a compromise offering the best features of both

[1] M. L. Lesser and J. W. Haanstra, "The Random-Access Memory Accounting Machine, System Organization of the IBM 305," *IBM Journal of Research and Development*, Volume 1, No. 1, January 1957.

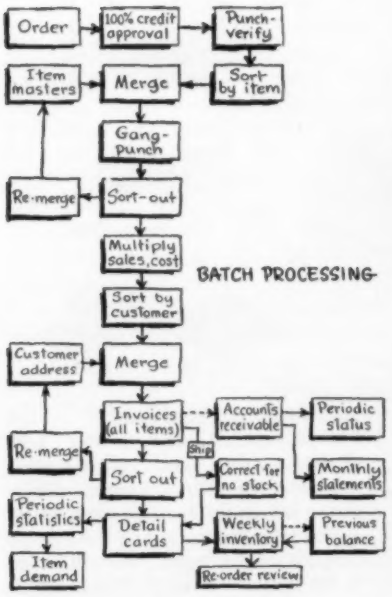
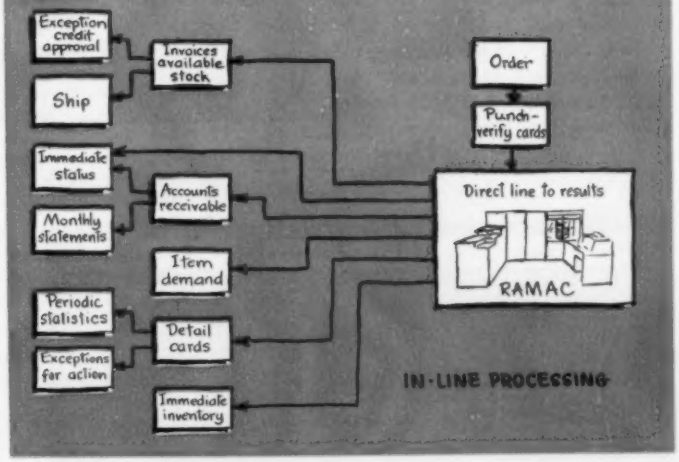


Fig. 2—Comparison of a typical punched-card batch processing operation with an in-line processing operation built around a system containing a random access memory.



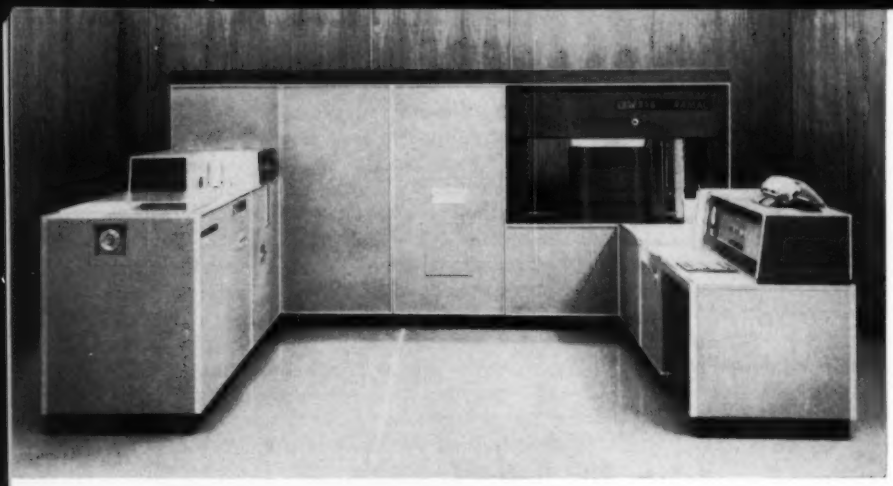


Fig. 3—Special data processing machine, 305 RAMAC, which was built around the magnetic disk memory unit.

the control panel and the stored program type of control systems. All information transfers during transaction processing are made via a stored program. Arithmetic operations in the machine are handled in substantially the same manner as information transfer instructions. All logical decisions are made by means of selector wiring on a control panel.

The general approach is to set up the conditions for control with the information transfer instructions and then to wire the means of considering these conditions on the control panel. *Fig.* 4 shows the system organization. Information enters the system via the card reader and is written directly from the reading brushes onto the magnetic drum housed in the processing unit. On the next card cycle, the information is read at a check station and compared with data on the drum. Following a successful check, the information is available under program control within the process unit.

The processing unit magnetic drum contains 33 tracks of 100 characters each and there is circuitry for manipulating information on the drum according to a program that is also stored on the drum. Twenty of the drum tracks can be directly addressed from the drum counter and make 200 programed steps of 10 characters each directly available for use. Additional programed steps may be brought from any storage point in the system

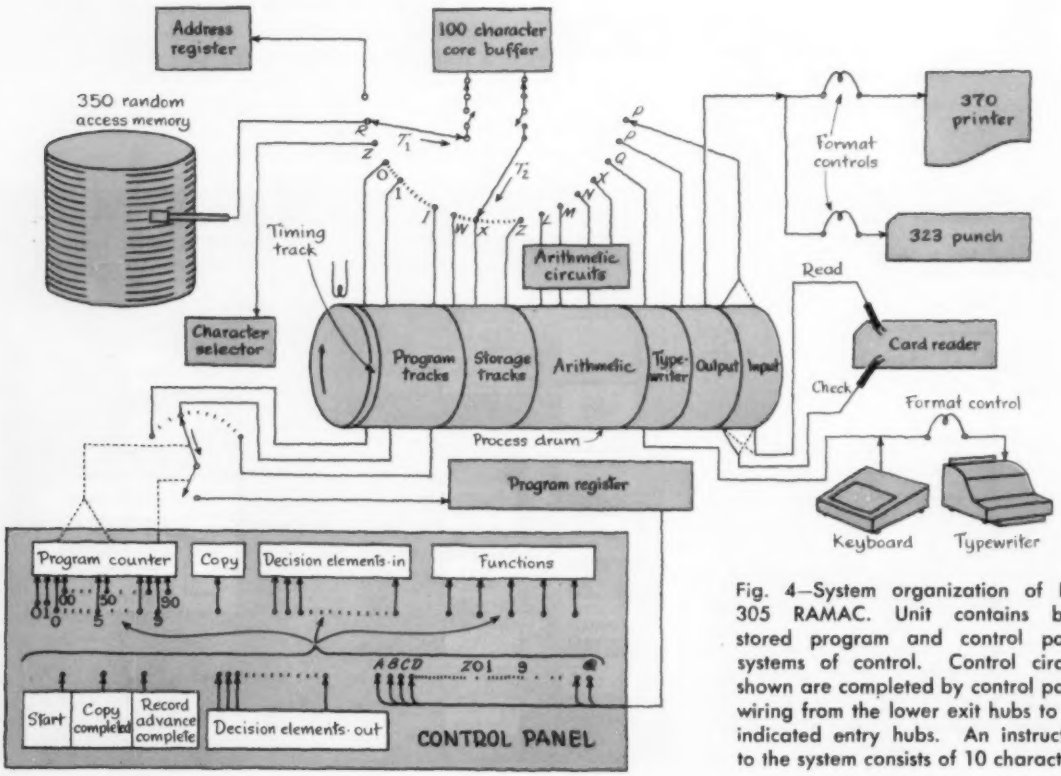


Fig. 4—System organization of IBM 305 RAMAC. Unit contains both stored program and control panel systems of control. Control circuits shown are completed by control panel wiring from the lower exit hubs to the indicated entry hubs. An instruction to the system consists of 10 characters.

and the 20 program tracks may be used for general storage as well as program storage. In addition, there are four general storage tracks, three tracks used in the arithmetic system, a track for use with the keyboard and printer unit on the console, two tracks for input, two tracks used for output, and a timing track. The random access file is connected to the processing unit at two points: the address register and a 100 character core buffer. The address register, which specifies the information to be read from the file, is a five-position storage unit. Numbers from any part of the processing unit may be sent to the register. The selected information of the file unit, as specified by the address register, is available to the processing unit through the core buffer for reading to procure information from the file and for writing to place new information in the file. The results of processing are sent to the output tracks on the drum. The printer and punch take data directly from these tracks and print and punch information according to the rules set down in their respective control panels.

As has been mentioned, the memory can be interrogated for specific facts at any time. All that is required is that the location of the desired information be keyed into the keyboard, and at an appropriate time, this information is procured from the file and placed on a special track of the process unit. Typing of the information from this track proceeds independently of normal processing.

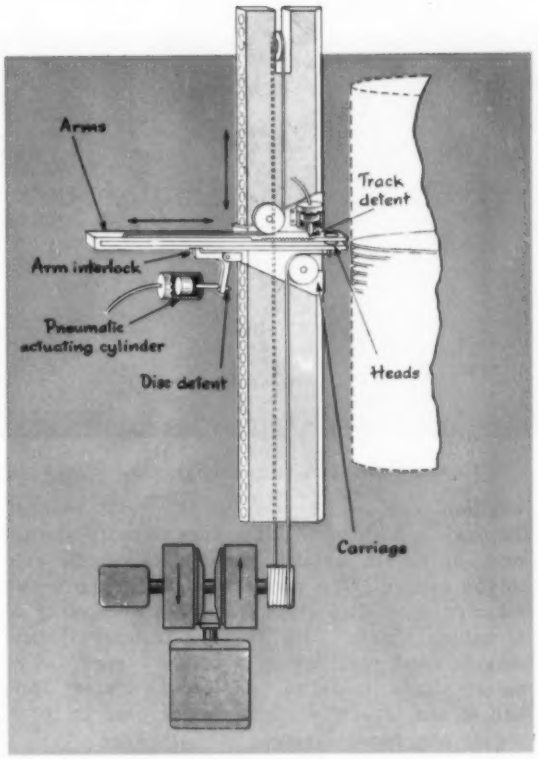


Fig. 5—Diagram of access mechanism. As many as three access mechanisms are used on a single disk file.

▸ Access Mechanism

The use of disks in vertical stacks permits multiple access mechanisms to be used. Theoretically, 20 access mechanisms could be installed, but no more than three access mechanisms have been used.[2] As can be seen from *Fig.* 5, the mechanism positions a pair of magnetic heads mounted in a pair of arms. The magnetic element in each head consists of two distinct magnetic circuits. One circuit, with its coil, erases only. The other circuit reads and writes. The erase element erases a wider track than the following write element records. This design does not require high precision in radially positioning the heads, in that there are no magnetically disturbed track edges to contribute noise to the newly recorded track which might not precisely coincide with the track previously written.

A spacing of the heads from the disk is maintained by an air bearing obtained from minute air jets in an annular manifold surrounding the magnetic elements. Such a design insures the holding of a 0.001-inch spacing despite the actual runout in the disk, and there is never physical contact between the heads and the magnetic coating.

Movement of the access mechanism is provided by a pair of magnetic powder, motor driven, counterrotating clutches. These clutches have a common output shaft on which is located a drive capstan and are linked through a pulley system to the carriage which moves vertically and the arms which move radially. At each of the 50 disk positions, a detent hole is provided in the vertical way. A pneumatic detent piston is energized upon arrival at the desired disk. This detent, by means of a mechanical linkage, controls an interlock which locks the carriage and frees the arms for radial drive. The linkage also frees the carriage and locks the arms for vertical drive. The arms are capable of being freed only when the carriage is positioned properly at a disk, and the carriage is capable of being freed only when the arms are completely outside of the disk, thereby preventing mechanical damage to the disk array. In addition to the detent for locking the carriage, a detent is provided to position the arms accurately to the selected track.

▸ Part of a System

By the addition of a magnetic random access memory to a medium sized computer, an extremely versatile data processing system can be obtained. In the 650 RAMAC, various component machines are grouped together to form a complete system, *Fig.* 6. The basic element is a stored program data processing machine. Up to a total of three card-read punches and line printers, in any com-

[2] T. Noyes and W. E. Dickinson, "The Random-Access Memory Accounting Machine, The Magnetic Disk, Random-Access Memory," *IBM Journal of Research and Development*, Volume 1, No. 1, January 1957.

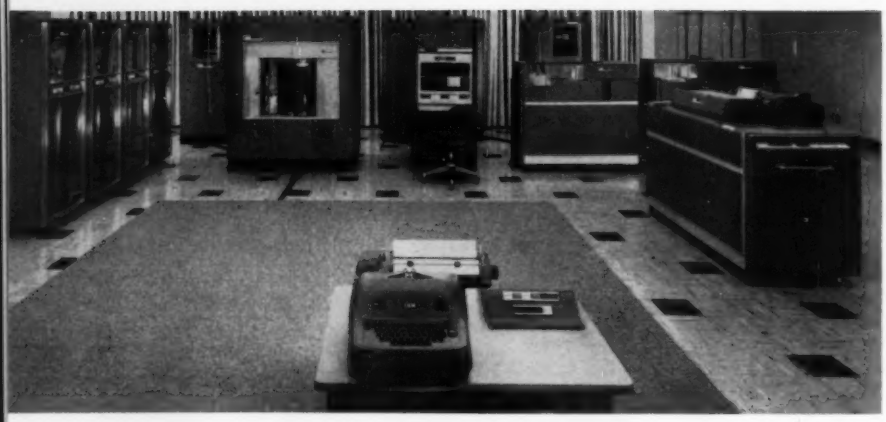


Fig. 6—Magnetic disk memory can be incorporated into a medium size computer system. Up to four memories and up to 10 inquiry stations, the latter shown in foreground, can be linked together in a 650 RAMAC installation.

bination, can be attached to the basic element. Through a high-speed input core memory storage unit, up to six magnetic tape units can be used in the system. The magnetic disk random access memory used with the system has a capacity of 6 million digits. Up to four memory devices may be used, resulting in a storage capacity of 24 million digits. And to complete the system, from one to ten inquiry stations can be used to interrogate the random access memory files.

The random access memory is similar to the memory unit used in the 305 RAMAC in manner of operation. An individual memory includes 50 disks, or 100 faces, which can be used to store data. Each face has 100 data tracks and each track holds 600 digits. The unit is equipped with three access arms.

Inquiry stations can individually interrogate the memory at any time. The replies are sent only to the interrogating unit. Since up to ten inquiry stations might possibly be used, the machine designers anticipated that some companies might prefer to control the extent of interrogation of certain information in the files. Under these conditions the inquiry to the machine and replies from the files are monitored by the program in the basic system element. The nature of each interrogation is determined and honored only if the originating station is authorized to make the inquiry.

ELECTRODATA's DATAFILE

MEMORY AND DATA ORGANIZATION

MAGNETIC TAPE possesses a number of distinct advantages in data processing applications. To the ElectroData Div. of the Burroughs Corp., the advantages—low cost, versatility, simplicity and reliability, which have been proved in extensive use—were too significant to ignore in attempting to solve the general problem of access to stored bulk data.

The basic concept of the company's solution to the problem of access is straightforward: If reels of tape are unsuited to rapid access primarily because of the limitations in speed of handling long lengths, then the solution involves the use of shorter lengths of tape. As a result of this approach, ElectroData has developed the Datafile 560, *Fig.* 7. The unit augments their existing line of magnetic tape equipment and, though capable of good random access, it is primarily considered to be an improved high capacity storage device for digital computer systems.

Magnetic tape used has a base coating on Mylar plastic and is ¾-inch wide. Recording density is 100 decimal digits per inch with 0.360-inch gap between the last digit of one block and the first digit of the next. Included in this space are the block address and other signals. Twelve channels, recorded across the width of the tape, are grouped into two lanes of six channels each. The six channels of one lane are interlaced with the six channels of the other, *Fig.* 8. Each lane has a separate read-write head, but when used with a computer, one lane only is read or written at one time.

Four of the six channels in each lane contain information in a 1-2-4-8 binary code. The fifth channel contains a parity check bit, and the sixth channel is reserved for a block marker, which signals the four-digit block address. The address digits occupy the same channels as the digits of the stored data.

Equipment is available for automatically inspecting tapes prior to use and regularly checking worn tapes, rejecting those areas that have manufacturing or other flaws. Tapes may be spliced as often as necessary without destroying their value. Thus, it is possible to utilize lower quality tapes, and effect a considerable financial saving for the user while still maintaining optimum tape reliability.

The read-write circuits and the tape processing equipment compensate for signal distortion that may come from dust particles on the tape or from other operating difficulties. True information is represented only by a change or no change in mag-

netization. Constant scanning of a built-in checking code, together with an automatic reread process compensate for transient errors and guard against a reading error because of component failure. If a defect is sensed, the block in which it occurs is automatically reread a number of times as set by the programmer. If the defect persists, an alarm sounds in the computer and the program stops.

The magnetic tape system is built around a single control unit that contains all the control and comparison circuits to accommodate up to ten Datafile storage units. Utilization of one control unit instead of individual control units for each tape storage device gives maximum flexibility in that the number of storage devices may be adjusted to meet the needs of a particular application. Ordinarily, the tape control unit is directed by commands from the computer. However, for such operations as calibration, it may be controlled manually by pushbuttons located on the main control panel.

▸ Storage Means

The model 560 Datafile stores information on fifty 250-foot lengths of magnetic tape brought out over guide rods and hung in bins separated by static-free metal partitions. On each of the 50 tapes, 1000 blocks numbered 000 through 999 are recorded in each lane. Thus, there are 2000 blocks on each tape for a total of 100,000 blocks of 20 words each or 2 million words per tape storage device. There are a total of 100 lanes on which to read or write information and these are designated 00 through 99. Two sets of read-write heads serve all 50 tapes of the Datafile. The carrier holding the heads moves the entire distance over the 50 tapes in less than 2 seconds, and stops precisely in position over a specific tape to read or write. Any tape of the 50 may be moved backward or forward while being searched.

Head movement time is approximately linear with respect to the number of tapes traversed. Whenever the head is moved from one tape to another, a relay release and final latch-in require a maximum of 0.5-second. The average time to traverse one tape after initial acceleration is 30 milliseconds. Random access time to any block of data in a large system containing ten of the storage units has been computed to be 16.3 seconds. However, if data that are changed or updated frequently are stored near the center of each tape, thus cutting head and tape movement to a minimum, then access time can be reduced to a fraction of a second, *Fig.* 9.

The tape unit possesses an independent search feature, which permits the computer to continue with its calculations while the tape is searched for the desired block of data. When a tape search is completed, the block addressed is in position for reading or writing. After the desired operation is completed, the next block following is in position to be acted upon by the heads. Reading requirements are reduced considerably since addressed blocks can be located conveniently. The tape block addressing feature coupled with the ability to recognize an address while searching in either direction, permits the most efficient handling of file information. Approximately 83 changes of tape direction are possible in one second during the search command. The programmer may call for from one to 100 blocks of data at a single command, and return the updated information to the identical position on the tape with a second command. Information may also be changed or deleted from any block without rewriting the entire tape. Thus, only active items need be brought into the computer for processing.

In use of the equipment, it should be recognized

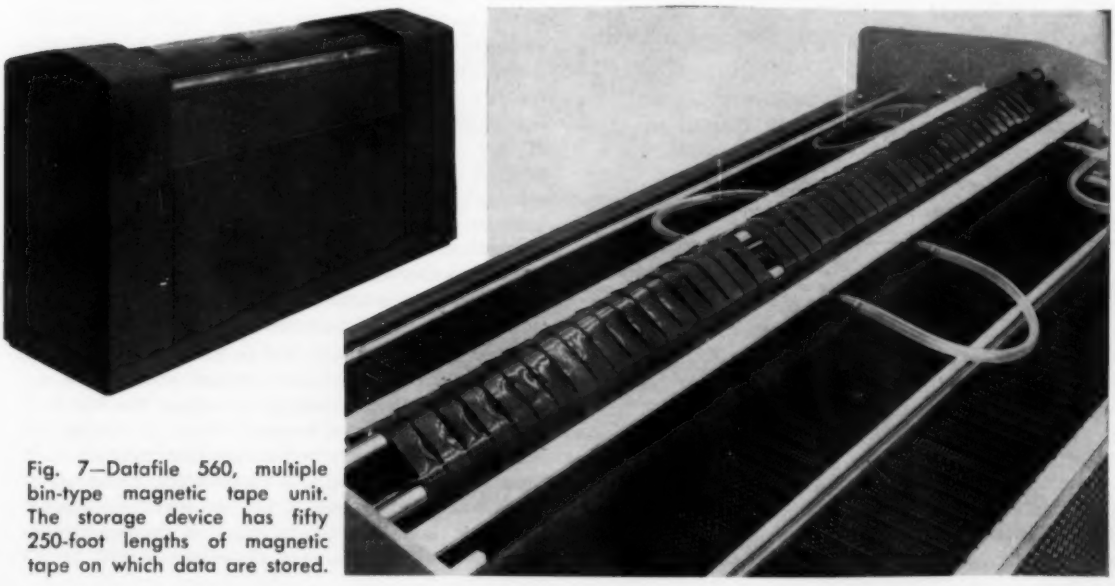


Fig. 7—Datafile 560, multiple bin-type magnetic tape unit. The storage device has fifty 250-foot lengths of magnetic tape on which data are stored.

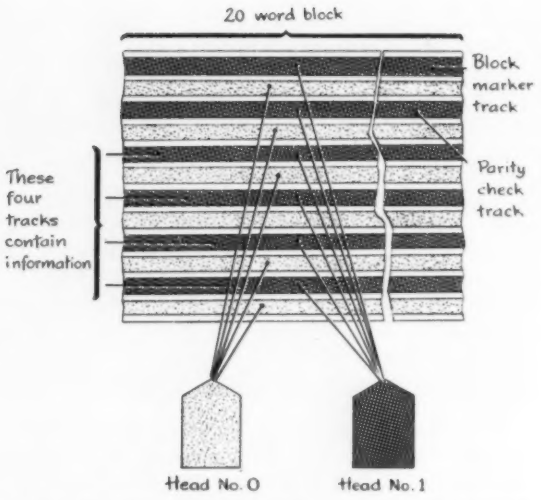


Fig. 8—Magnetic tape provides 12 tracks or channels which are arranged into two interlaced lanes, designated odd or even, each of which consists of six channels. A read-write head is provided for each lane.

that significant gains are to be had through organization of the file format based upon the peculiarities of a given application. A variety of arrangements is possible and by careful selection of methods, maximum storage capacity and minimum access time can be obtained.

For instance, the Datafile is ideal for high speed sorting when used in conjunction with a Datatron computer's 4080 word memory drum capacity as temporary additional storage. Since each tape unit contains 50 tapes, the most effective way to reduce sorting time is to block sort on the highest digits. The memory drum is used as a 50-pocket sorting and storage medium preparatory to searching and writing on the tapes. For practical purposes, records must be less than 800 digits in length in order to make effective use of the memory drum and the 50-pocket method. Tapes are searched and written on only when one of the 50 pockets is full, thus reducing head movement and searching time considerably. After the entire file has been block sorted, each tape is read back to the memory drum for fine sorting on the remaining digits. Actually, the entire file is only written on the tapes twice, once after block sorting and once after fine sorting. For maximum efficiency, fine sorting should be accomplished by comparison or address approximation, rather than by actual value of the remaining digits.

Examples of Average Random Access Using the Datafile

Example	No. of Units	No Rec. in File	Digits Per Rec.	Lanes Used	Blocks Per Lane	Avg. Access in Seconds
A	1	22,000	200	80	275	5.12
B	1	52,000	100	100	260	4.99
C	1	400,000	40	100	800	13.24
D	1	6,000	800	100	240	4.68
E	2	200,000	200	200	1000	16.30
F	3	18,000	2000	240	750	12.40
G	10	18,000	2000	1000	180	8.25

Fig. 9—Examples of average random access time of applications involving various numbers of Datafiles.

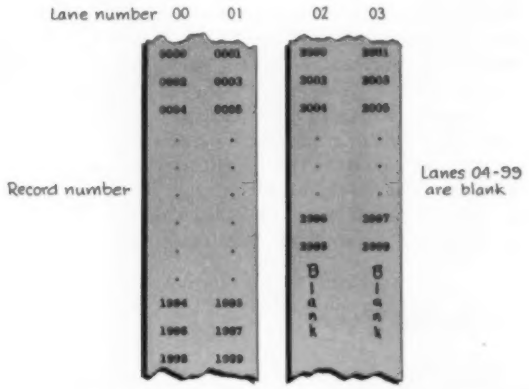


Fig. 10—In lane-parallel tape layout, records are arranged alternately on two lanes of each tape. This continues for two tapes that are required to store the 3000 blocks of the example.

File Arrangement

Several unique file formats are possible with the multiple tape memory units. For example, consecutively numbered records can be stored alternately on both lanes of two tapes (lane-parallel method). A typical file reference problem might involve 3000 records of 200 digits each. The records are numbered 0 through 2999; and are recorded the length of two tapes, *Fig.* 10. Stored information is to be printed out, updated and returned to storage. By storing the 3000 records in a lane parallel sequence, the distance on the tape to be searched is reduced considerably. Search proceeds in the forward direction using both sets of heads at the same time, and back search is eliminated. Average access time per record is 5 seconds.

The tape-parallel method is an extension of the lane-parallel method, and further reduces the access time to any record by spreading the file over all 100 lanes of the memory, *Fig.* 11. Using the same problem as in the lane-parallel method, each tape would contain only 60 records and a number of tapes would be skipped during the search command. Although head movement time is increased considerably, average access time per record is re-

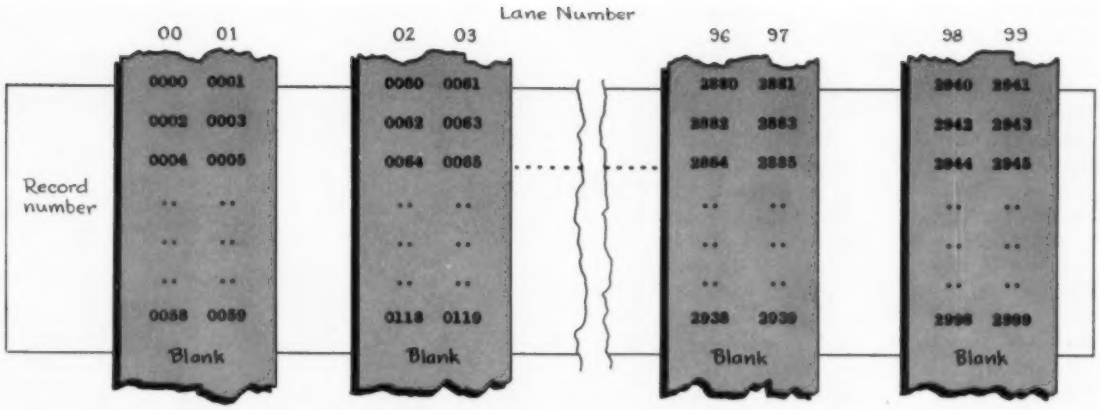


Fig. 11—Tape-parallel layout is similar to lane-parallel layout, except that 3000 records are dispersed over entire 100 available lanes of the data file.

duced to 1.25 seconds. For a large volume of data, this method may be applied to several data files connected to a single control unit.

For an application where the data cannot be conveniently kept in sequence, the multiple tape memory has its greatest advantage. The number of lanes over which the records are spread is the key to the average random access time for all records, and the optimum number, b, to select can be determined directly from the formula, $b = 0.12\sqrt{ac}$ where a is the number of records in the file and c is the number of characters per file.

In problems of inventory control, billing, accounts receivable and payable, where various records have to be referenced and updated more than others, favorable record distribution for processing is possible. Using a curve of normal popularity distribution, the more active records are concentrated on the tapes in the central part of the machine surrounded on each side by less active records. On each lane of tape, the central area will hold the high-volume items, with the lower volume items tapering off to either ends of the tapes. The file will be completely out of sequence identification-wise but in sequence demand-wise.

Again, with inventory, billing, and accounting problems, data can be separated such that dynamic information is kept in one file, and static information is kept in another. Only the dynamic file requires updating. When a periodic summarization is required, the two files may be run simultaneously (not merged) to yield the necessary print-out, including all totals and descriptive information. The dynamic data may constitute only one-tenth of the total file in which case only one-tenth requires reading and writing.

POTTER's RAM

MEMORY IN COMMERCIAL APPLICATIONS

ELECTRONIC DATA PROCESSING has expanded within the past decade to a point where today some form of such equipment is being used or contemplated in virtually every phase of industry. One of the major roadblocks on the way to higher automation of information systems has been the lack of a large-scale fast-access memory system to replace the perennial filing cabinet and its attendant clerical difficulties. Existing data processing systems are capable of handling transactions with split-second efficiency, but crippling delays usually accompany the storage and transfer of information to be processed or which has been processed.

To overcome the memory roadblock, Potter Instrument Co. Inc. has designed its RAM (Random Access Memory) units, *Fig.* 12, for the storage and convenient utilization of large quantities of digital information. One unit is capable of storing more than 500 million bits of information in as many as 400,000 locations, with access to any desired location in a fraction of a second.

▶ Rectilinear Motion System

Fast access and large storage capacity are made possible by using magnetic tapes filed on racks in an automatic 3-dimensional storage machine. Information is recorded on lengths of conventional 8-track magnetic tape strung vertically on the racks. The racks are hung five abreast in a five-compartment storage bin, with all five racks in each row being treated as a single page and handled together. There are 1000 racks composing 200 pages in a storage bin, and although only one bin at a time can be handled by the machine, bins can be exchanged to provide even greater

storage capacity. Bins are positioned on locating pins in the machine, and changing is performed in a few minutes with a hand operated lift truck.

Each page holds 100 strips of tape, 50 side by side on each face of the page. Five read-write heads are provided on each side of the page so that positioning of a head with reference to a desired tape requires only a short time. Appropriate switching selects the proper head for the track being used. The storage mechanism is designed to position any page in 10 vertical positions which define 10 areas on each of the tapes on that page. Each area can be divided into two data locations by electrically selecting data from only one of the locations in the area being read. With 200 pages, 100 strips of tape per page, 10 vertical positions for each page, and two data locations for each vertical position, a total of 400,000 data locations are available in the 200-page bin. Since 160 characters of 8 bits each can be recorded in each data location, the total capacity of the unit is 512 million bits.

Mechanical positioning of the pages and heads is accomplished by pneumatic cylinders controlled by solenoid valves, *Fig.* 13. Each of the three positioning actions (page selection, page lifting, and head positioning) is actuated by its own serial train of pneumatic cylinders. The strokes of the cylinders in each train represent increments in a modified binary code, and any desired position is obtained by selectively actuating certain of the cylinders in the train. Motions are transmitted

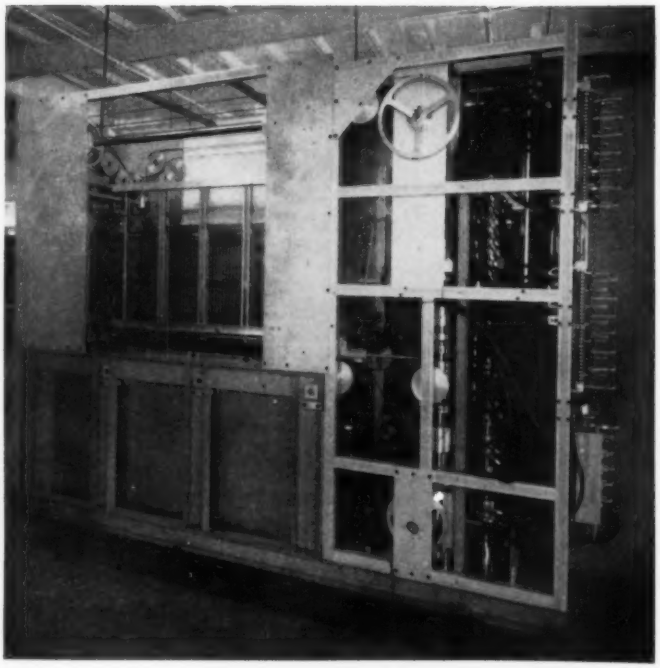


Fig. 12—Magnetic tape memory device designed by Potter Instrument Co. Inc. stores information on strips of magnetic tape. Tape strips are strung vertically on "pages" which are positioned for reading or recording of information. Pneumatic cylinders performing the positioning are at right in the photograph of a stripped down machine. Motions are transmitted from the cylinders to machine members by flexible steel tapes. Access to any desired data location requires less than 1 second.

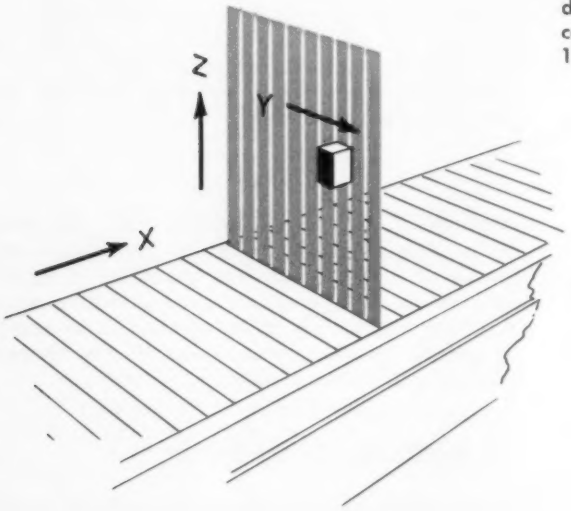
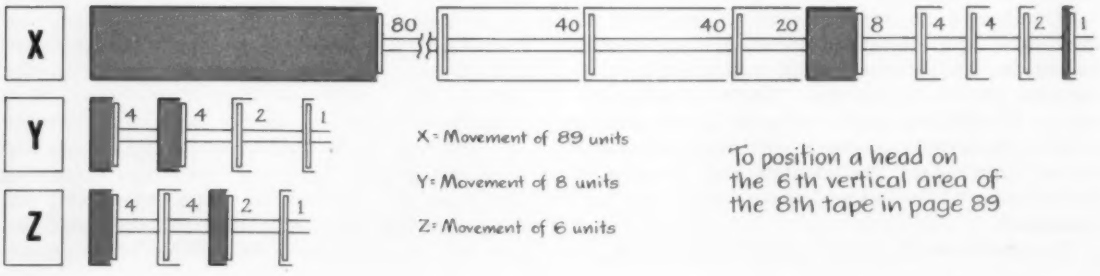


Fig. 13—Sketch illustrates the three trains of pneumatic cylinders which perform the positioning functions: Finding the desired page out of 200, elevating the page to one of ten positions, and positioning a read-write head. Strokes of the cylinders in each train are such that selective actuation of certain cylinders in that train give a total movement of the desired distance.



from the cylinder trains to the members being moved by means of steel tapes. The motions in different trains are programed to protect limiting surfaces, and mechanical and electrical interlocks prevent damage to the equipment in case impossible addresses are specified.

In normal usage, one of the eight tracks on each tape is used for parity check and one is used as a clock track, leaving six tracks for coded alphanumeric information. Positive and negative saturation recording is employed with return-to-zero or non-return-to-zero techniques. Reliability is based on the use of conventional magnetic tape techniques. Read-write heads, *Fig.* 14, are brought into direct contact with the tape, and phosphor bronze head construction is used to prevent digit drop-outs caused by oxide pickup which may be experienced with plastic encapsulated head assemblies. When the selected read-write head has been positioned adjacent to the selected location, a stroking mechanism is activated which passes the head over the location to insert or abstract information.

The access mechanism may be used to process several storage bins, thus providing virtually unlimited storage capacity for applications where data may be divided. For example, a single mechanism may be used to process payroll data stored in one bin and inventory data in another.

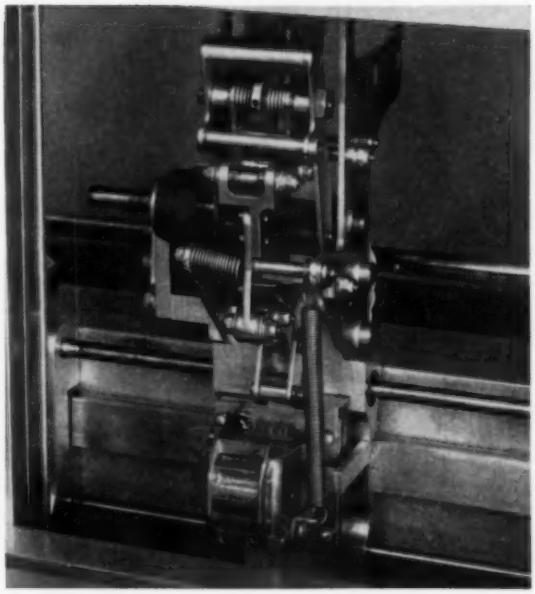


Fig. 14—One of the standard 8-channel read-write heads used in the RAM machine. After the desired head and tape are properly positioned, the head is stroked down past the selected data location to read or record information there.

Development and Applications

Preliminary work on the Potter RAM began nearly a decade ago. By early 1950 mock-ups had been fabricated to check the principle involved, and on December 2, 1952, U.S. Patent No. 2,620,389 was issued to John T. Potter, inventor of the RAM and president of the company. Subsequent patents pertaining to the RAM were issued in 1953 and 1954, each emphasizing some phase of the three-dimensional rectilinear motion memory system. According to Mr. Potter, development costs have exceeded $500,000 and many approaches have been considered. The design now being manufactured has been subjected to electrical and mechanical tests, including the life testing of components for millions of operations.

In general these units are intended for use where fast access to tremendous quantities of digital information is required. Applicable input devices include keyboard, magnetic tape, perforated tape, or information directly from a computer. The units may be used to feed high-speed line-at-a-time printers or tape handlers; or information may be fed directly into buffer storage systems for processing in computers and other data-processing systems.

Typical applications include magazine subscription fulfillment, maintenance of insurance company records, banking transactions, transportation and entertainment reservations, inventory control, record keeping in mail order houses, etc. In subscription fulfillment the units may be used to store records pertaining to hundreds of thousands of subscribers. Additions, deletions and revisions may be made in less than a second. When the units are used to prepare mailing lists, the latest possible information is used. Insurance companies are often plagued with record-keeping delays which can be costly both in good will and dollars and cents. With split-second access to filed information, such delays can be eliminated. For inventory control, stock records can be kept current by instantaneous updating as withdrawals from and additions to stock are made. At convenient intervals, the memory unit may be used to activate a high-speed printer system to tabulate stock information.

In banking institutions the units may be used to store balances and other pertinent data. Programed for instantaneous updating, such a system can provide valuable information in completely random form whenever required. By keeping track of seat, flight and date information, these units can speed the processing of airline reservations and are applicable to other reservation list problems where fast and random access to records is desired.

Part of the gap between the electronic computer that can follow recorded instructions and the machine that requires human supervision is the inability of the machine to remember large quantities of instructions and to store partially processed information. Random access memory units can serve as an auxiliary memory for digital computers, increasing their remembering capacity and their ability to make decisions based on experience in the form of prerecorded information.

PHOTOELECTRIC READERS CONTROL RIVETER

RIVETING of aircraft panels to frame members can require thousands of operations for a single assembly. Hundreds of accurately located holes must be drilled in the parts, rivets must be fed into the holes and upset, and exposed rivet heads shaved off flush with the skin surface. One of the important elements in these operations is accurate positioning of the parts with respect to the work heads. General Riveters Inc. has developed a machine that mechanically moves the cumbersome parts into position under a head which can perform all the necessary operations.

At Northrop Aircraft Inc. such a machine, *Fig.* 1, has been equipped with punched tape controls and can automatically perform the positioning and other actions required to complete cycles for seven rivets per minute. Two men can set up the machine and a single operator completes four units in the same period of time which would be required for five men to complete one unit with manual methods.

Parts being assembled are mounted on a holding fixture supported at each end by a dolly. These dollies move transversely on a carriage which travels longitudinally on a set of tracks 60 feet long. Transverse movement of each dolly is individually powered by a reversible air motor and controlled by its own punched tape unit. The air motors are a piston-type supplied by Keller Air Tools Co. The dollies move on contour tracks so that the surfaces of the curved parts being riveted are horizontal at the point where operations are being performed.

The contour tracks carrying the dollies are moved up and down on screws driven by geared electric motors built by Century Electric Co. Longitudinal travel of the carriage is generated by a hydraulic system built by Vickers Inc. This longitudinal system is controlled by a third punched tape unit which also sequences machine actions.

Tapes used in the three tape control units on this machine are opaque 35 mm Dupont Kronar film. As many as seven rows of holes or channels may be punched across each tape. Setup of the machine is accomplished by sighting-in a master part with a transit. Location of each rivet hole is thus pinpointed accurately and the machine's three tapes are then punched with data corresponding to the positioning and cycling requirements.

Each tape is read by photoelectric means, *Fig.* 2. A light source on one side of the tape energizes a photoelectric cell on the opposite side of the tape when a hole in the tape passes between them. For the channel controlling longitudinal travel of the carriage, auxiliary sensing means are mounted on each side of the photoelectric cell. To take care of inertia forces the auxiliary means reduce the speed of the carriage before the photoelectric cell stops the carriage in the proper position.

Punched holes in other channels on the tape then trigger the following operations: The drilling head drills, reams, countersinks and counter bores each rivet hole in one pass with a single tool; a rivet slug is automatically fed into a rivet injector which places it in fingers that transfer it into the drilled hole; a rivet-set above the hole then restrains the rivet while it is upset under a force up to 16,000 lbs by a rivet-set below the hole; the rivet is then shaved flush with the skin. Due to the slight counterbore no feather edge is left by the shaving process. The bottom rivet-set is automatically lowered to clear projections, such as ribs or stiffeners, while the table travels. This rivet-set is then raised after the table stops.

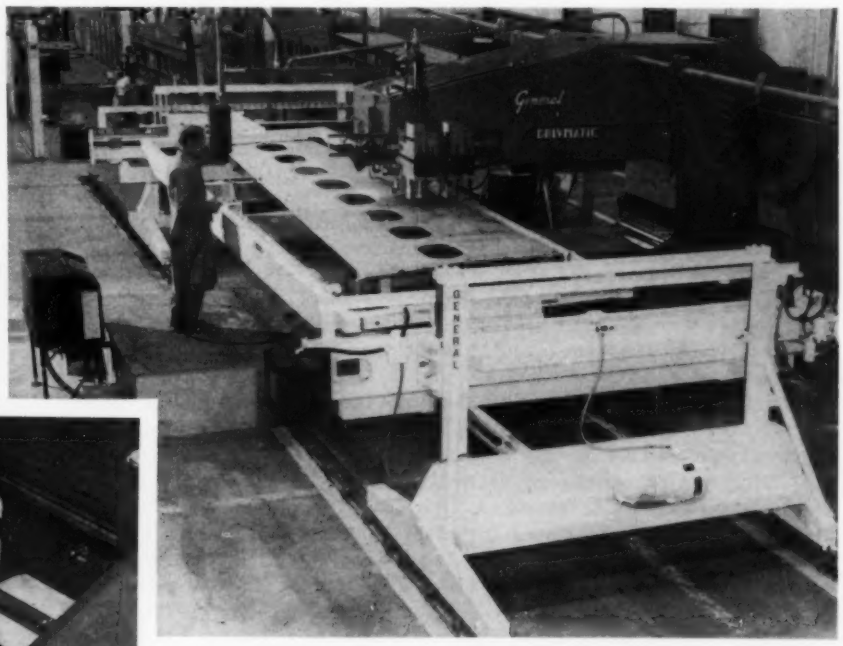


Fig. 1 — Tape controlled machine automatically positions airframe parts, drills and rivets them.

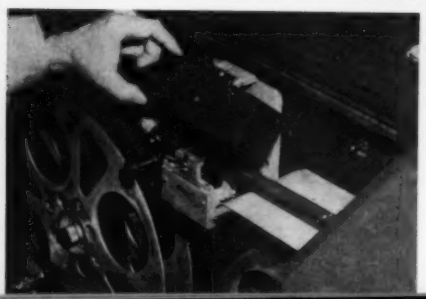
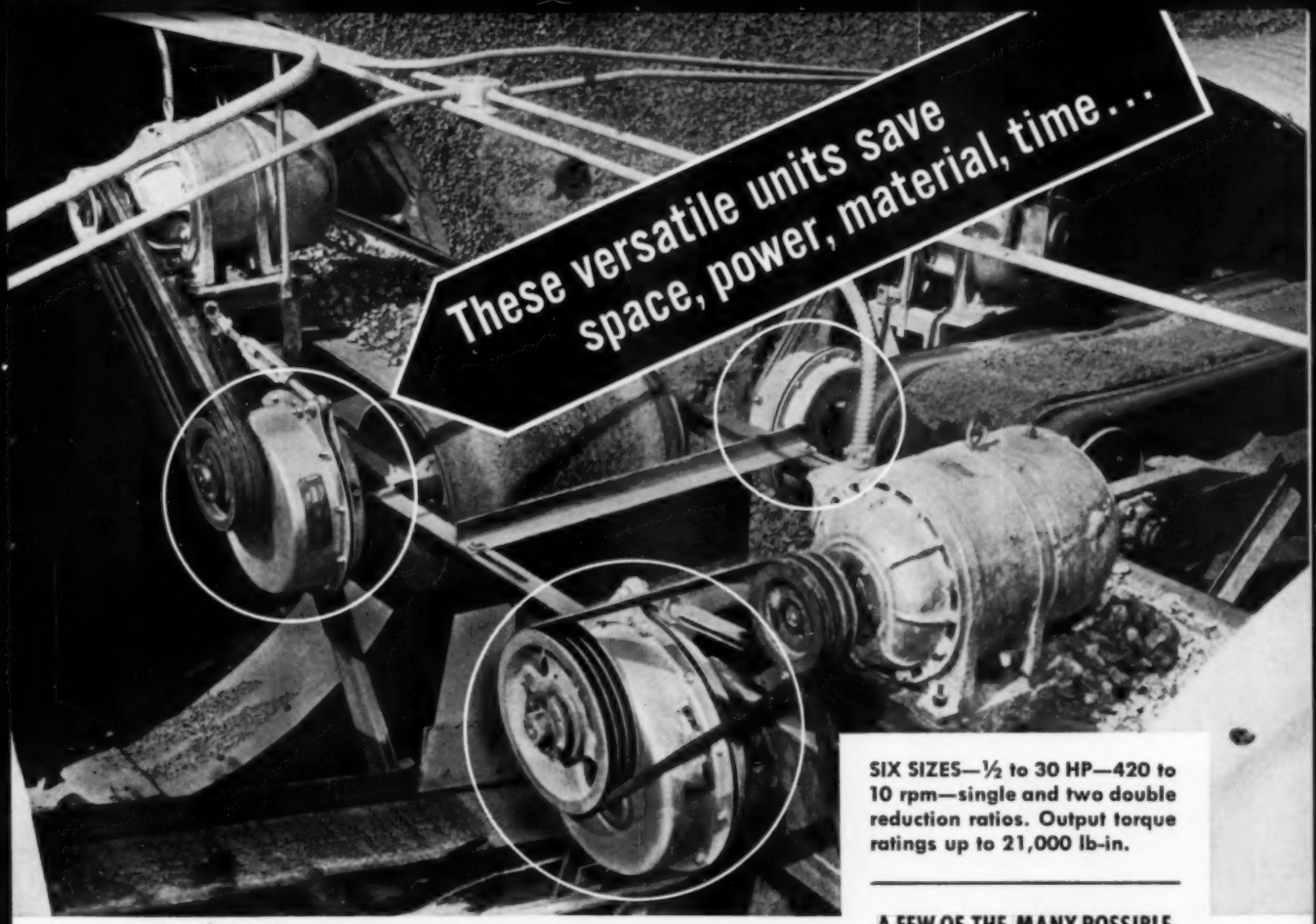


Fig. 2 — Commands punched in three opaque 35-mm films are sensed by photoelectric readers such as this. Provision is made for seven channels across each tape.



SIX SIZES—½ to 30 HP—420 to 10 rpm—single and two double reduction ratios. Output torque ratings up to 21,000 lb-in.

FALK ALL-STEEL Shaft Mounted Drives

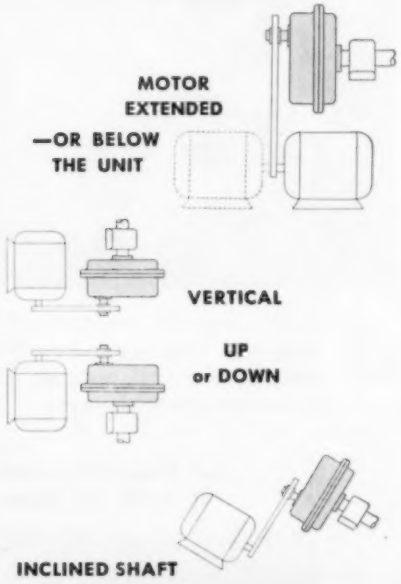
The photograph above typifies the way FALK Shaft Mounted Drives furnish the economical solution to problems of efficient speed reduction in a limited space. Within their rated capacities, these versatile reducers are designed to drive any machine and to fit any space requirement.

FALK Shaft Mounted Drives mount on the driven shafts and are connected by V-belt or chain to any convenient rotating power source. Unlimited choice of output speeds between 420 and 10 rpm is made possible by varying the ratio of driving sheaves or sprockets.

These units, with precision-cut gears of highest efficiency, use a minimum of power. They need no adjustable motor bases or slide rails; thus they save material. And, because they are readily available and easily installed or moved, they save time. Best of all, they are backed by FALK's unmatched experience in precision-gear manufacture.

Promptly available from factory and distributor stocks, from *coast to coast*. Ask your Falk Representative or Distributor for details—or write us for **Bulletin 7101.**

A FEW OF THE MANY POSSIBLE DRIVING ARRANGEMENTS



THE FALK CORPORATION, 3001 W. CANAL ST., MILWAUKEE 1, WIS.

Representatives and Distributors in Most Principal Cities

Manufacturers of

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

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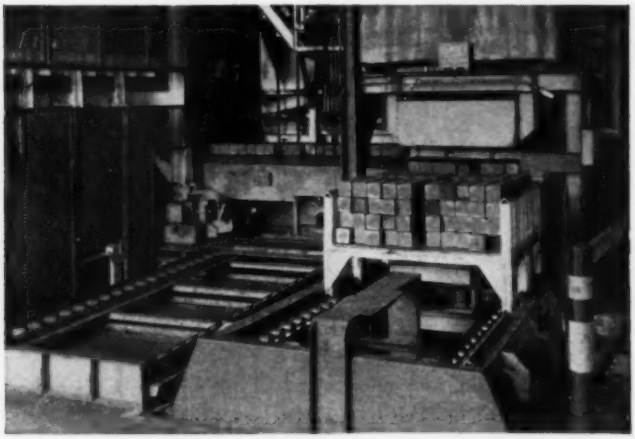
FALK

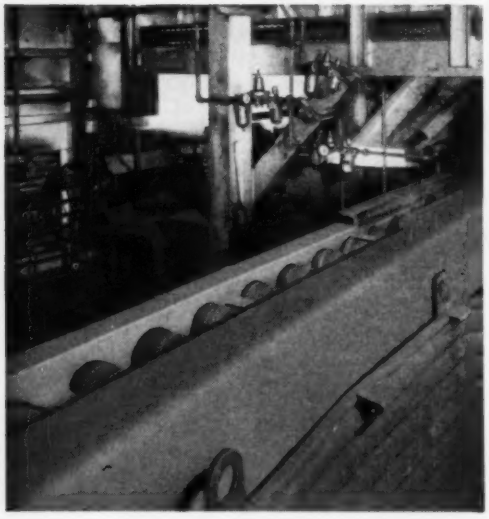
...a good name in industry

Hand Handling Eliminated On 6000 Ton Forging Press Line By Planet System

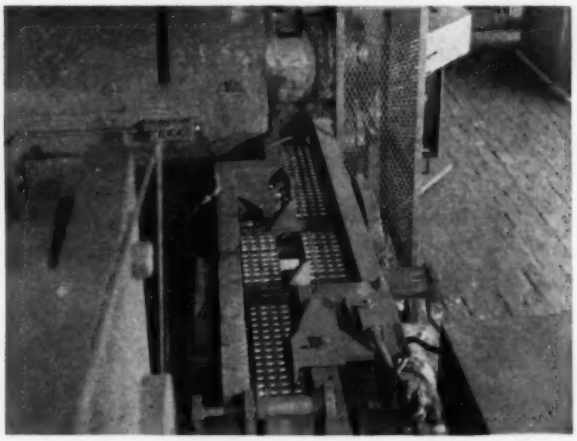
Billets Moved in Continuous Flow From Furnace Through Trimming Operations While Still in Forging Temperature Ranges



In this system, which was recently installed in a large automotive forge plant, a steady flow of billets is insured by the automatic rack unloader. This unit feeds billets automatically into the furnace and moves empty racks away for pick-up.



Hot billets are carried rapidly and in a continuous flow from furnace to the first reducer roll by a powered roller conveyor.



From reducer rolls hot billets are moved to presses, and enroute are turned by roller chain repositioning unit.

Let Planet Help Solve Your Handling Problems — Write or Phone Today
"IT PAYS TO PLAN WITH PLANET"

PLANET CORPORATION

1810 SUNSET AVE., LANSING, MICH.

- **ENGINEERED HANDLING SYSTEMS**
- **AUTOMATED EQUIPMENT**
- **FOUNDRY HANDLING SYSTEMS**

68

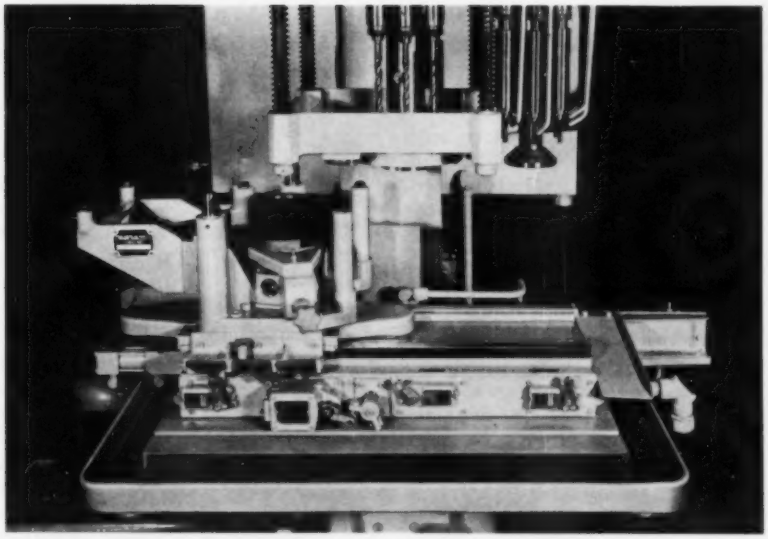
Circle 678 on Inquiry Card

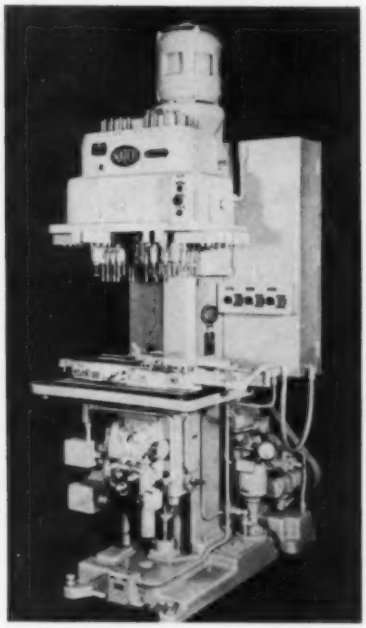
AUTOMATION

new equipment

Machines and plant equipment designed for more automatic operations

For detailed information and literature, use card page 17





Cycle Controlled Drilling and Tapping

AUTOMATED drilling and tapping for small lot production of a great variety of parts usually handled by gang drills are made practical by Model H-6 multiple-spindle drilling and tapping machine. Developed by **National Automatic Tool Co. Inc.**, Richmond, Ind., the machine is now available with preset selective cycle control and a straight-line indexing slide.

Machine Advantages

With this new Natco combination, production rates are often equal to or higher than those of single-purpose special machines, according to K. P. Martin, vice president in charge of sales. Operators are freed for other duties and setup times are greatly decreased. Cost of production and floor space are also minimized.

Operating Cycles

In use, the operator unloads the finished part, loads a new one and depresses the starting switch. The machine then goes through all operations and returns to the loading position. More than 100 combinations of operations are possible simply by setting selector dials. Machining functions include drill, tap, step drill, chamfer, countersink, counterbore, spotface and skip. Table movement in the drilling cycle consists of rapid traverse up, feed up and rapid traverse down. The tapping cycle includes rapid traverse up, feed up, feed down and rapid traverse down. In the chamfer cycle (including countersinking, spotfacing, etc.), rapid traverse up, feed up, dwell and rapid traverse down are performed. The table can also be arranged to travel a further distance for drilling than for chamfering operations. In the typical application shown at left above, the first position is used for unloading and loading. Part is drilled in second position and tapped in third position.

Controls

Table feeds are controlled by means of two dials, one for drilling and another for tapping. Taps of different leads can be used because of the vertical float arrangement built into the spindles. The hydraulically actuated indexing slide is electrically controlled by means of the selector switches and is available with two, three, four or five positions. Various workholding fixtures can be mounted on the slide.

Machine Elements

The basic machine consists of a multiple-spindle geared head and a hydraulic feed table. Spindles are driven through universal joints; they can be arranged with adjustable arms for positioning or can be fixed in the required layout by a slip spindle plate fastened to

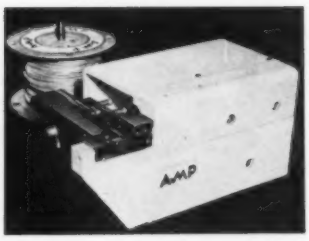
the head of the machine. Up to 24 spindles can be used on the H-6, depending primarily upon horsepower consumed. Spindle drive motor is 3 hp on the standard model, and 5 hp on the heavy duty machine.—*Circle 401.

Palletless Handling

Item 428 — Handling normally palletized goods without the aid of pallets is possible with multiple attachment used with Model E trucks. The attachment consists of multiple forks, side shifter and pushoff device.

In a typical industrial application, goods might be flowing off a production line. Instead of being palletized at the end of the line, they would be received and stacked on a multiple-prong device. To pick up the load, the fork truck operator inserts his truck's six forks between the prongs and raises his forks. With the load on the forks, he travels to the storage area. At this section, the operator deposits his load on special all-steel storage racks which are of cantilever type construction.

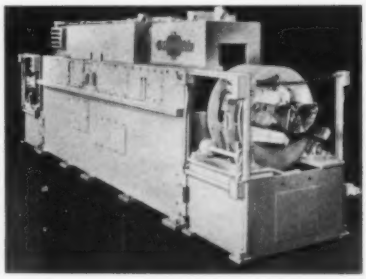
The side-shifter attachment makes possible horizontal movement of the forks to further ease placing and removing goods from the racks. A remote control button, located on the left side of the truck's mast, raises or lowers forks to proper working heights without walking around to the truck's main controls. **Lewis-Shepard Products Inc.**, Dept. R-5, 125 Walnut St., Watertown 72, Mass.—*Circle 428.



Automatic Splicer

Item 419—Designed to produce up to 1200 identical, mass produced splices per hour on enamel, polyvinyl acetal and similarly coated wire, horizontal machine is well suited for assembly line production. The automatic splicer with multiple ring stripping action eliminates scraping, dissolving in solvents, burning or other methods of removing insulation.

The splice is engineered to lock wires and connector into a high tensile strength splice. The joint is hermetically sealed during splicing, making it corrosion resistant. The splices can be used on solid or stranded conductors or combinations thereof. **AMP, Inc.**, Harrisburg 13, Pa.—*Circle 419.

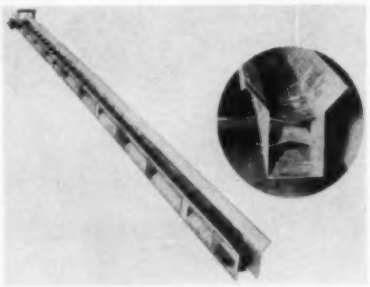


Tunnel-Type Broaching

Item 416—Developed for automated processing of engine cylinder blocks, tunnel-type broaching machine is suitable for a wide range of like components. Parts are automatically fed to the machine through a turnover positioning unit for one-pass overhead broaching by a hydraulic traveling ram. Transfer units progressively move the parts into an elevating station for broaching.

In an application for broaching ten bearing surfaces of a cast-iron V-8 cylinder block, an automatic cycle time of 29.5 seconds can be obtained with the 6-ton, 54-inch stroke model of the tunnel machine. Cutting speed is 30 fpm.

For this operation, six parts are kept in sequence, one in an entry turn-around unit, four in the machine proper, and one in the exit turn-around unit. Line conveyors feed and remove the engine blocks. Transfer bars move the inverted parts through the machine. At the broaching station, a hydraulic elevator raises the part into broaching position with an alignment to 0.0005-inch. Locating pins hold the part to ±0.001-inch. The overhead broaching operation removes a maximum of 0.025-inch of stock in one pass leaving a good surface finish. **Colonial Broach and Machine Co.**, P. O. Box 37, Harper Station, Detroit 13, Mich.—*Circle 416.

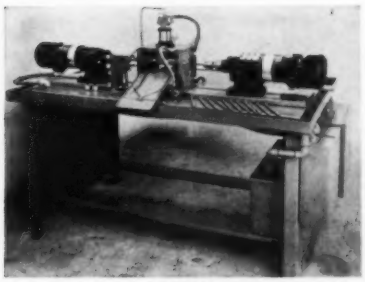


Specialty Conveyor

Item 427—Developed to handle small parts for a variety of industries, conveyor is designated Model 600-Z. The unit is portable and adaptable to any required height or length. Riveted sections are bolted together making the conveyor expansible to 32 ft. from a standard 12-ft length. It is designed to clear any opening, such as floor traps, bin doors, small windows, port holes, etc.

The conveyor is available both as Model 600-ZA with a self-cleated rubberized belt and as Model 600-ZM with a steel mesh belt. Both types combine to permit coincidental washing, sifting, screening and cleaning of vegetables, foundry products, etc. Belt speeds can be varied by pulleying; standard speed is 135 fpm. **American Planter Co.**, Burr Oak, Mich.—*Circle 427.

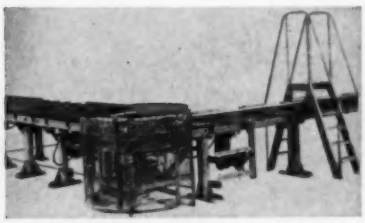
*For Inquiry Card, see page 17



Double-End Driller

Item 429—Designed to automatically end drill armature shafts or similar parts, double-end drilling machine is an example of small-scale automation. A grinding operation precedes the drilling operation. The grinding operator places the ground shafts in the loading chute of the double-end driller, which then end drills the shafts automatically.

The parts are automatically escaped one at a time into V-blocks, where they are clamped after a cam locates the part accurately. The drill heads are electrically interlocked and complete the drilling cycle, after which the part is automatically ejected and a new part loaded. The machine has a built-in coolant system. Drilling heads and the clamping fixture are keyway mounted, allowing accurate alignment and easy adjustment. The design is readily adaptable to double-end chamfering or reaming operations for a range of part sizes. **Automation Development Corp.**, 135 Reynolds Rd., Mentor, O.—*Circle 429.



Mechanical Drive

Item 407—Used in an application with transfer conveyors, mechanical drive handles automobile engine heads in an automobile engine manufacturing plant. The installation illustrates transfers with two different strokes. The tangent line on the right operates on a 34-inch stroke, while the tangent line on the left operates on a 12-inch stroke. Both strokes are synchronized with each other. The shuttle bar operates on a 15-second cycle and is driven by a ⅓-hp standard motor. Faster cycling time is available if desired. Advantages of the drive include efficient operation, low operating costs, low maintenance and adaptability to close tolerance indexing. **Spurgeon Co.**, 23501 Hoover Rd., Van Dyke, Mich.—*Circle 407.

Error Printer

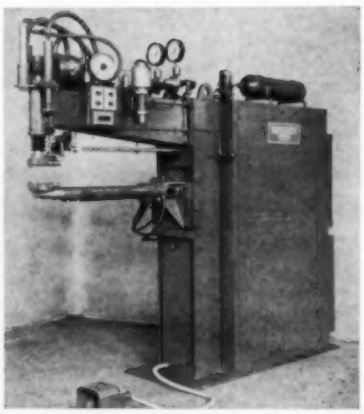
Item 431—Automatic print-out accessory is designed for use with company's automatic circuit testing system. It permits the printer fully automatic operation and reduces operator attendance.

Detecting a fault, the error printer waits a predetermined period. It then prints out the socket and pin numbers of the faulty circuit, and a letter indicating the type of fault. The circuit testing system is then tripped and advanced to the next test automatically. **Lavoie Laboratories Inc.**, Route 4, Morganville, N.J.—*Circle 431.

Seam & Spot Welder

Item 406—Air-operated electric resistance press model is a combination seam and spot welding machine. As a seam welder, the upper and lower heads are rotatable to either side to permit either transversal or longitudinal seam welding. The Model PMM.OC-50-36 (illustrated) is designed to seam and spot weld light gage metals to military and aircraft specifications.

The machine's pressure system is capable of exerting a maximum of 120 lb electrode force under air line pressure of 80 psi. The pressure system is designed for accurate control of the low electrode force required, and for rapid follow-up. The low inertia pressure system provides maximum strength with minimum friction. The welding transformer is designed for single-phase, ½-cycle unidirectional operation. It does not saturate with this type of operation, within the limits of machine capacity. A series-parallel tap switch is provided to extend the range of heat adjustment. The main transformer is rated at 50 kva.

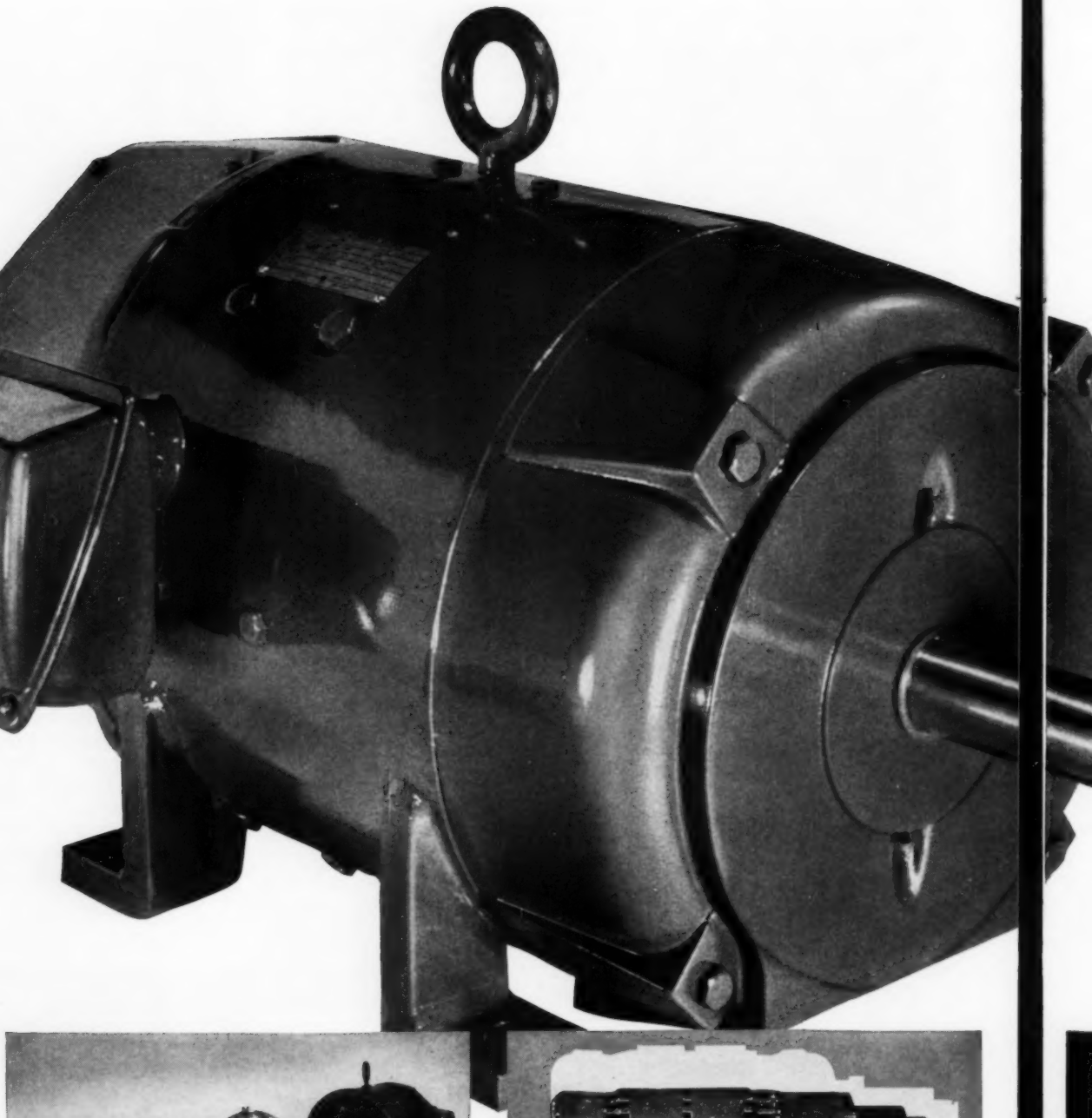


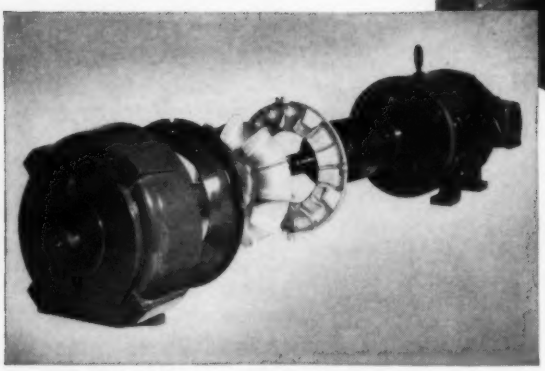
Machine timers include squeeze, heat and cool (synchronous), hold and off. For spot welding operation, a repeat provision is made. Phase-shift heat control provides continuously adjustable secondary current. **Sciaky Bros. Inc.**, 4915 W. 67th St., Chicago, Ill.—*Circle 406.

Variety Packager

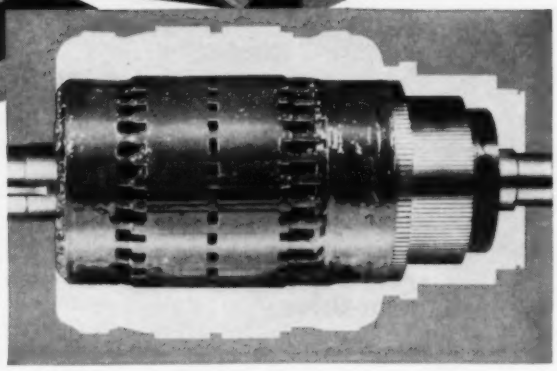
Item 405—Elimination of cardboard in the wrapping of such baked goods as hamburger buns and cinnamon and sweet rolls is afforded by high speed, variety packaging machine. The 47-H variety wrapping machine packages sliced, clustered buns and rolls or loose rolls without cardboard or any other type of support at speeds up to 65 packages

*For Inquiry Card, see page 17





NEW CONTROLLED VENTILATION—pushes air through the motor from drive end to commutator end, opposite to the ordinary direction. Armature cooling is increased... harmful brush dust created at the commutator is blown out of the motor.



NEW LEVEL OF RESPONSE—Improved ventilation makes up to 55% lower armature inertia possible without sacrifice in capacity. Life-Line "H" gives the fastest accelerations and regulating speed changes for more and better production.

Westinghouse *Life-Line H* with silicone insulation

FASTEST RESPONSE OF ANY STANDARD INDUSTRIAL MOTOR

Life-Line® "H" Backs Up Lowest Inertia With High Commutating Ability for Increased Production

Highly responsive drives are essential to fast automatic processing. No other d-c drive provides as fast speed changes as the Westinghouse Life-Line "H".

Efficient controlled ventilation makes possible the long, slim design of the Life-Line "H" armature, reducing inertia as much as 55% without sacrificing any capacity. 35% increase in commutating ability backs up this lowest inertia to produce the fastest response available in standard industrial d-c motors today.

In addition, the new Life-Line "H" with silicone insulation, offers many dividends in long-term dependability and minimum maintenance. For all the facts about Life-Line "H" call your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. Ask for B-7056. J-21991-C

NEW HOUSING DESIGN—provides maximum protection—eliminates need for splashproof enclosures in many cases. All access openings are sealed with covers . . . single ventilation opening in each bracket faces directly down.

YOU CAN BE SURE...IF IT'S

Westinghouse

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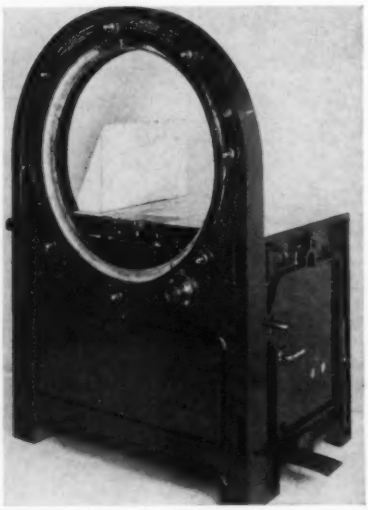
a minute. The wrapper may also be equipped with a labeler, a label imprinter and one-shot lubrication.

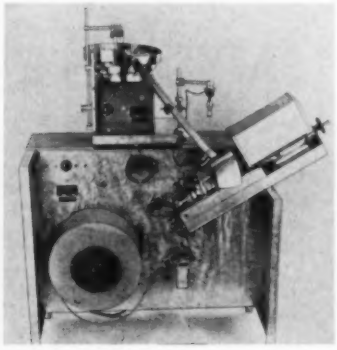
Simple changeover is obtained by using hand wheels and interchangeable tuckers. Material savings can be realized through the elimination of trays, U-boards and bottom cards. **Battle Creek Packaging Machines Inc.**, Battle Creek, Mich.—*Circle 405.



Wire Tying Machine

Item 447—Capable of operating at a speed of up to 20 wire ties per minute, fully automatic wire tying machine affords tensional strapping speed and efficiency for large and continuous packaging volume. The Auto-Wire Strapper handles wooden boxes, cartons, crates and bales with equal efficiency, since the wire tie or ties can be placed in any desired position around the length or girth of the package, reinforcing it against damage.

Taking packages of different sizes as they are fed in without any adjustment being necessary, the machine straps each package to a uniform degree of tension automatically. Once the tension is fixed, it remains constant until reset. The strapper operates with 14, 15, 16, 17, 18, or 19-gage wire, depending on type and weight of package to be tied. The machines are available in two sizes—standard ring gear and large ring gear. The former takes cartons and wooden boxes to a maximum size of 16 inches high by 22¾ inches wide to 19¾ inches high by 15 inches wide. The minimum size is 4 inches high by 8 inches wide. The large ring gear model will take cartons and wooden boxes to a maximum size of 20 inches high by 26 inches wide to 25½ inches high by 15 inches wide; minimum size is 4 inches high by 8 inches wide. **General Strapping Corp.**, 100 Park Ave., New York 17, N.Y. —*Circle 447.



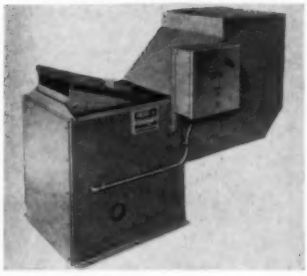
Tube Inserter

Item 420—Unit that automatically cuts off correct lengths of plastic tubing and inserts them firmly into aerosol valves and flat or nasal plugs operates at production line rates up to 140 per minute. Caps are fed to the tube insert station from a hopper that is equipped to position for proper delivery, reject defects, and count. **Chase Equipment Corp.**, 47 E. 19th St., New York 3, N. Y.—*Circle 420.

Chip Separator

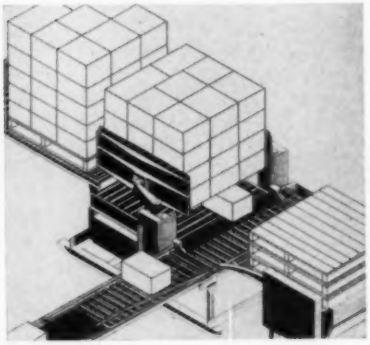
Item 432—Designed to eliminate hand riddling and picking in screw machine operations, machine separates work and chips. Loss of valuable parts is halted, chip quality is upgraded, and damage to chip balers or presses is prevented.

To operate the machine, both work and chips are placed in the vibrating loading pan. They are fed over a sloping screen and subjected to an air blast from below. The work drops through the air blast and passes out the work discharge chute located at the side. Chips are blown upward as they



pass over the sloping screen. As the air expands and is deflected upwards through the screened top of the extended hood, the chips drop out of the air stream and are deposited under the hood.

The extended hood eliminates air blast back pressure and prevents the possibility of chips flying out of the vibrating loading pan. **Ransohoff Inc.**, North Fifth St. at Ford Blvd., Hamilton, O.—*Circle 432.



Pallet Unloader

Item 404—To receive pallet loads of cases and automatically unload each pallet onto a conveyor line, device is called the Alvey De-Palletizer. The cases move away from the load individually in single file, at a rate of 25 to 30 cases per minute.

The incoming conveyor on which the loaded pallets are deposited, usually by lift truck, may be designed to specific installation requirements. In some cases this line can be long enough to provide loaded pallet storage ahead of the depalletizing operation. The off-bearing conveyor line can also be designed to suit special plant requirements. **Alvey Conveyor Mfg. Co.**, 9301 Olive St., Rd., St. Louis 24, Mo.—*Circle 404.

*For Inquiry Card, see page 17

720 Assemblies Per Hour AUTOMATICALLY!

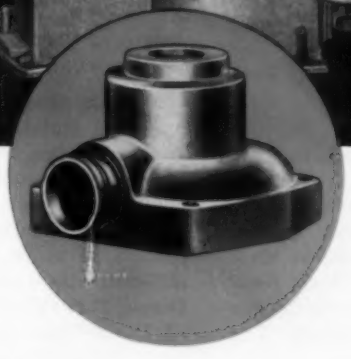
This Robbins "Assemblimatic" feeds, positions, assembles and unloads automatically . . . producing 720 four-piece assemblies every hour! It assembles a needle bearing, washer and seal in two sizes of a steering gear end cover. Parts are fed and positioned from indexing magazines, and completed assemblies are removed and placed on a conveyor . . . all automatically.

Machine features include: (1) Robbins panel, one-third standard size, with plug-in aircraft type relays and controls which prevent assembly unless parts are correctly positioned, (2) Index table with both barrel type cam and shot bolt for accuracy and magnetic operation of index and dwell, (3) Positive dwell time control through synchronous timer and electrical interlock at each station, (4) Hardened and ground ways, (5) Automatic lubrication, (6) Electrical and pneumatic equipment to J.I.C.

Robbins special assembly machines save manpower, speed production and improve quality, often combine machining with assembly for further savings. Automatic inspection, selection, orientation, assembly and in-process gaging assure consistent high quality production. Ask us for recommendations to help solve your automatic assembly or machining problem.

OMER E. ROBBINS COMPANY
24806 PLYMOUTH ROAD • DETROIT 39, MICH.

New brochure describes and illustrates a variety of Robbins special assembly machines. Write for your copy.



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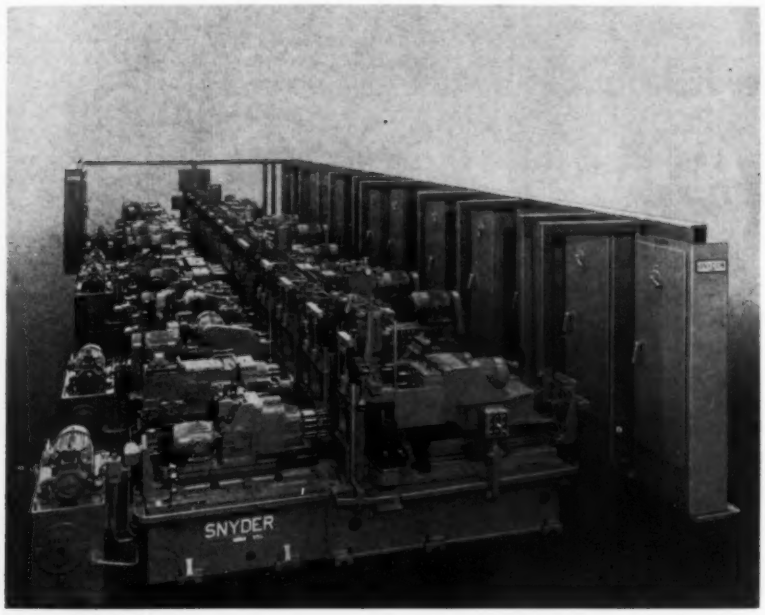


Segmented Processing Machine

Item 434—Hydraulically operated, electrically controlled 53-station machine drills, spotfaces, chamfers, reams, line reams, taps, mills and bores cast iron, sliding gear, transmission cases at a net production rate of 80 cases per hour.

The machine utilizes part orienting devices to avoid use of vertical machining units. Parts are turned 90 degrees at Station 13 and tipped up 90 degrees at Station 38. Separate pushbutton controls and panels are provided for each of the 13 segments, permitting independent part clamping, machining and unclamping for setup and repair operations. To simplify tool changes, the spindles are arranged for preset cutting tools.

Hydraulic power for the standard way-type machining units on the machine is provided by five separate hydraulic pump and tank units spaced at intervals along the segments. A master control panel has pushbutton controls and lights that indicate the operating condition of each segment. A fully automatic lubrication system is also provided. **Snyder Tool and Engineering Co.**, 3400 E. Lafayette, Detroit 7, Mich.—*Circle 434.

Hydraulic Bar Feed

Item 456 — Designed to feed stock accurately, even at the high spindle speeds of late model single spindle screw machines, Hydra-Lite bar feed is designated Model S. A short piston allows feeding of stock at high spindle speeds without stopping the spindle. The unit has no feed finers to gall or mar stock. Positive feed-out insures control of lengths within a few thousandths of an inch. The Swing Stop accessory controls the length of piece part as accurately as a turret stop.

The bar feed requires a second operation clutch to assure trouble free operation. A signal light warns the operator when the machine is running out of stock. The feed is available in capacities from 3/32 to 1¾ inches in three different size units. **Boyar-Schultz Corp.**, 2124 Walnut St., Chicago 12, Ill.—*Circle 456.

Rotary Bonding

Item 446—Line of automatic multistation rotary cycle bonding machines with positive control of all primary bonding factors is available in a capacity range from single and multistation stationary types up to 40-station rotary types for permanently bonding liners to either internal or external surfaces. Applications include the bonding of automatic transmission parts and brake band linings, or aircraft or automotive components where two elements must be permanently joined together.

The machines offer complete control of all variables of any bonding method within the range and capacity of the unit's instrumentation, for pressure regulation, time and temperature. Instrumentation and fixturing available are flexible to any degree of absolute control required. Production flexibility is provided through independently operated banks of stations. A single-station model produces ten parts an hour; a 40-station model, about 400.

Models are available with fine instrument control whereby constant regulated voltage is applied and differential heaters are used to pick up heat losses caused by heat absorption of the part. The controls maintain a narrow range of variation in the heat band. Light indicators for high-low temperature, working range, out-of-range heat drift, and a temperature lockout provision are optional. Electrical operation is from a

*For Inquiry Card, see page 17

(Advertisement)

Progress Report:

SCHRADER AIR PRODUCTS PERFORM JOBS IN SEQUENCE—AUTOMATICALLY

• Don't send a boy to do a man's job

When you say that, smile, if you're talking about air. Air can do *more* than a man's job. It can perform complicated, time-consuming operations faster, more accurately, and much more economically than *any* man.

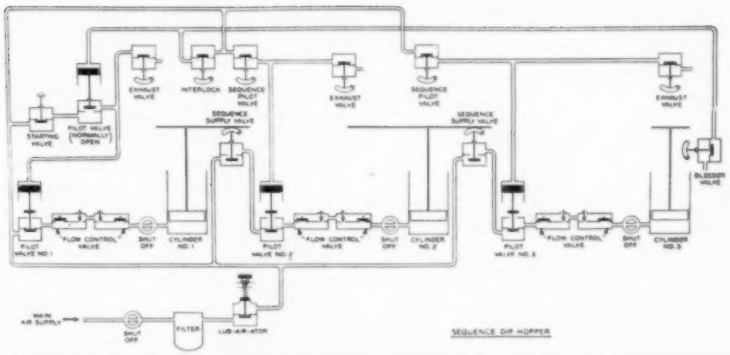
There was a time when air power was used for nothing but simple one-shot actions, but those days are far behind. Now, automation has brought air so far beyond the "bellows-in-the-forge" age that the contrast is startling.

Manufacturers who think of Schrader Air Products only for the so-called simple-minded jobs are missing out on one of the true revolutions of our times. Their competition is using air systems, on the other hand, to make precision operations to close tolerances, for operations in sequence, and you can't blame them if they're a little smug about the amazing effectiveness, economy, and safety they've developed.

FOR EXAMPLE:

• This job was driving sane men off their rockers

Until recently, the toughest job at a New Haven plating company was dipping baskets of plated parts in three successive baths. The triple bath sequence was not just monotonous – it was slow, expensive, in a corrosive atmosphere, and calculated to frazzle the tempers of workers. Then the operation was automated with Schrader Air Products. The dip hoppers now operate as if by magic—in solitary splendor. Completion of one sequence automatically starts another.



Schematic shows how a Schrader air system operates for plated part dippers, shortening the cycle, and releasing operators for more useful jobs.

The schematic on this page is eloquent. Combinations of Schrader cylinders, pilot valves, two way valves, and flow control valves have been engineered into a true automated sequence system. Once again, open-minded engineers discovered the best way—air—had definite advantages.

• What you don't know can hurt you

Most engineers already know that Schrader Air Products are available NOW, that the products are designed to be fitted together as simply as an Erector set, and that the hundreds of different parts available offer capabilities that are virtually limitless. Advantages? Well, here they are again: Exceptional economy is basic. Safety margins can be widened by the use of special control techniques. Simplicity of air systems allows fingertip-push-button-tiptoe operations that are fatigueless. Production is speeded up.

• Take a good look at yourself

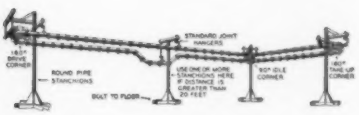
Better yet, let *us* look you over. Schrader engineers will be happy to assist you in planning for the most efficient use of air in your plant. And they'll be glad to recommend products which most readily suit given applications . . . even packaged control sets that are so perfected that most press hazards are eliminated. Both hands must be used at once and can't get into mischief. Any machine using mechanical clutch, shears, brakes and friction clutches can use special controls. You may be very surprised at how painlessly Schrader can turn your idea into fact. Information is available by writing directly to us . . . and our distributors are conveniently located for fast delivery. Address A. Schrader's Son, Division of Scovill Mfg. Co., Inc., 472 Vanderbilt Avenue, Brooklyn 38, N. Y.

Schrader®
a division of SCOVILL

QUALITY AIR CONTROL PRODUCTS

Circle 681 on Inquiry Card

440v source to a standard bus bar mounted at the top of each machine and through trolleys to one of several control panels. Automatic lubrication is provided with all models in the line. **Modern Industrial Engineering Co.,** 14230 Birwood Ave., Detroit 38, Mich.—*Circle 446.



Conveyor Supports

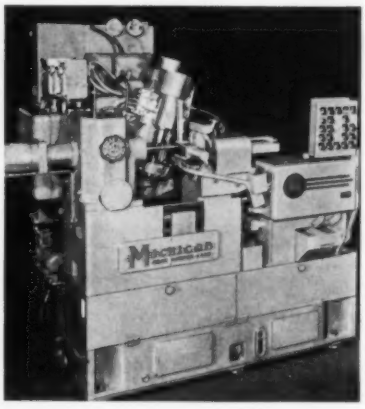
Item 411—Designed to simplify and reduce the cost of installing overhead cable conveyors, standardized floor - mounted supports make possible a package cable conveyor system. The supports eliminate the problems involved in installing cable conveyors when roofs are weak, too high, or cluttered with supports for other equipment and utilities. The supports may be lag bolted to the floor or may be simply placed on the floor and then braced to plant walls.

Hollow pipe stanchions are used with the standard brackets and adapters to make up the supports; all the parts are completely interchangeable. **Tipp Mfg. Co.,** Tipp City, O.—*Circle 411.

300-Ton Press

Item 444 — Two-point, straight side press for automatic progressive production is a single-geared center drive model capable of operating in the speed range of 75 to 150 strokes per minute with a standard 3-inch stroke. The 300-ton Piece-Maker P-2-300 unit is available with bed widths of 66, 72 or 84 inches, right to left, and 48 inches front to back.

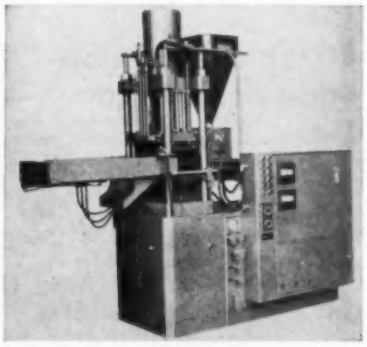
Design features of the press include the mounting of steel herringbone main drive gear in the center of the two-point full eccentric crankshaft. The gear is counterbalanced to equalize the weight of the crank eccentrics. The center drive construction reduces torsion and equalizes power transmitted to the slide connections. Standard single or double roll feeds are available to feed from either direction or front to back. Illustrated press has a single roll front to back feed driven from the crankshaft through spiral meter gears. The press provides maximum stability for continuous heavy blanking operations on materials such as high carbon steel. **Minster Machine Co.,** Minster, O.—*Circle 444.



Gear Hobber

Item 438—A new concept which is adaptable to any degree of automation, Model 1433 gear hobber can be set up in tandem or unlimited series with automatic through-feeding and removal of parts. Gear washers and classifiers can be integrated into the machine units. Automatic size control is provided.

All machine services are self-contained in the sub-base, including air or hydraulic pressure lines for operations of feeds, self-contained coolant system, conveyor for removing chips, used-coolant return lines, conveyor lines to remove finished parts, and central system lubrication lines. Features include a plunge cutter feed and an automatic expansion arbor for workholding. **Michigan Tool Co.,** 7171 E. McNichols Rd., Detroit 12, Mich.—*Circle 438.



Molding Press

Item 409—Featuring fast press cycles, high output per cavity, easy setup, and mold protection, Model 741 fully automatic compression molding press is used for electronic components, appliance parts, electrical components, automotive parts and sporting goods items. The press is available in capacities of 50, 75, 125 and 200 tons. Fast closing time (2.9 seconds from feed to die contact) plus fast pressing speeds (adjustable up to 27 inches per minute) permit the mold to be run hotter, shorten curing time, and thus allow maximum utilization of the fast-curing resins.

Preset feed boards need only a simple volume adjustment by the setup man the first time they are used, and then require no further adjustments. The presses are equipped to give the user a choice of either bottom ejection with top hold-down, or top ejection. Both knockout systems are fully positive. All press movements are automatically controlled by interlocks so that they occur in correct sequence. Each press motion depends upon the proper completion of the preceding motion, and any interruption to the cycle causes the press to stop until the condition is cleared and the operation restarted manually. Automatic

*For Inquiry Card, see page 17

COMPLETE *Finishing* SYSTEMS

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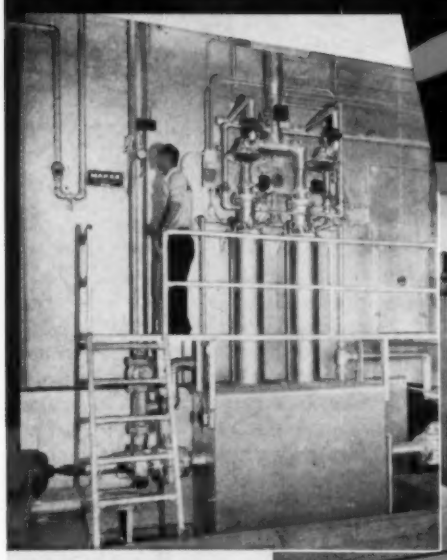
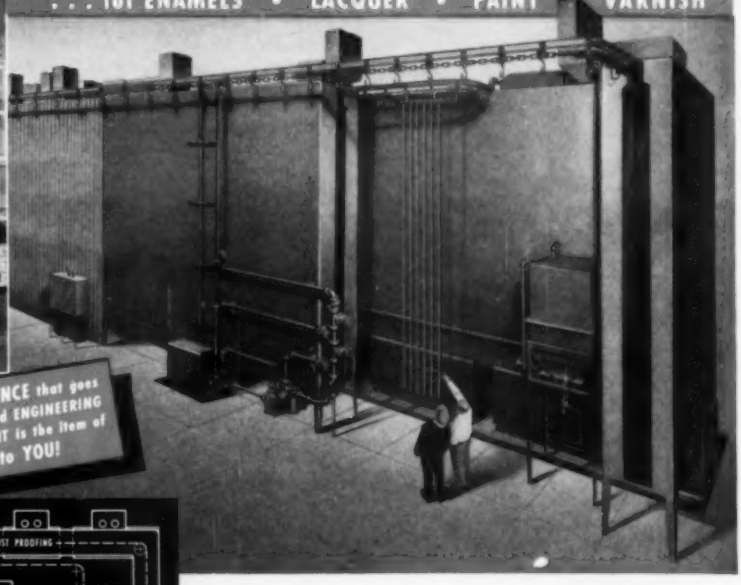
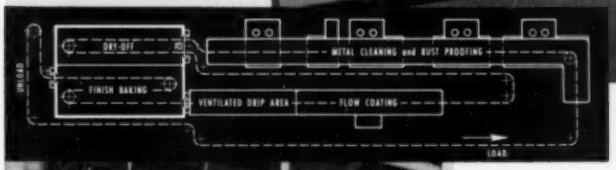
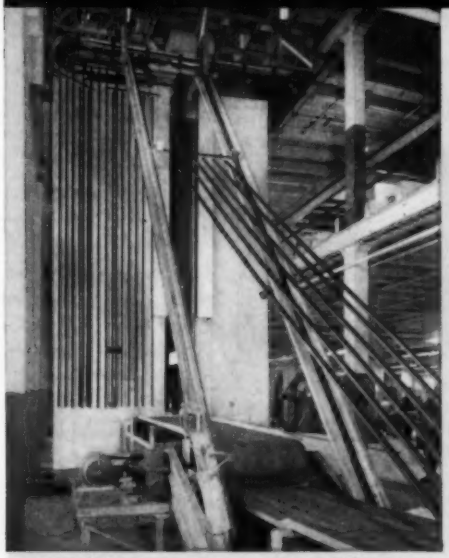


Mahon FIRE-JET Heating Units on the solution tanks of Mahon Five-Stage Metal Cleaning and Rust Proofing Machine—part of the Complete Mahon Finishing System at MULT-A-FRAME Division of Ainsworth Manufacturing Corporation, Detroit, Mich.



. . . the EXPERIENCE that goes into the PLANNING and ENGINEERING of MAHON EQUIPMENT is the item of GREATEST VALUE to YOU!





Exit end of Mahon combined Dry-Off and Finish Baking Oven showing Automatic Unloading Conveyor Ramp and Belt Type Handling Conveyors on the first floor at the Ainsworth Plant.

Ainsworth MULT-A-FRAME Channels are Painted in MAHON EQUIPMENT!

When the MULT-A-FRAME Division of Ainsworth Manufacturing Corporation was confronted with a finishing problem, they turned to Mahon for the solution. The product is a box channel 20 ft. long with only a ½" slot in one side—these are cleaned, rust proofed and painted outside and inside. Two hundred channels are finished per hour. Thousands of Fittings, Concrete Inserts and other MULT-A-FRAME parts and accessories are also finished on the same line. The finishing equipment extends from a pit in the first floor to the second floor ceiling. Oven Heating Units, Recirculating Fans and Exhaust Fans are located on the third floor. Automatic loaders and unloaders, with ramp conveyors from the first floor, load and unload the main conveyor which is located 27'-5" above the first floor. This is another Complete Mahon Finishing System designed and built by Mahon to do a specific job efficiently and economically. If you have a finishing problem, or are contemplating new finishing equipment, you will find that Mahon engineers are better qualified to advise you on both methods and equipment requirements . . . better qualified to do the all-important planning and engineering of equipment—which is the key to fine finishes at minimum cost. You will also find that Mahon equipment is built better for more economical operation over a longer period of time. Mahon's background history in this highly specialized field covers thousands of Complete Finishing Systems including Dip, Flow Coating and Spray Equipment for every conceivable product painted on a production basis. See Sweet's Plant Engineering File, or write for Catalog A-657.

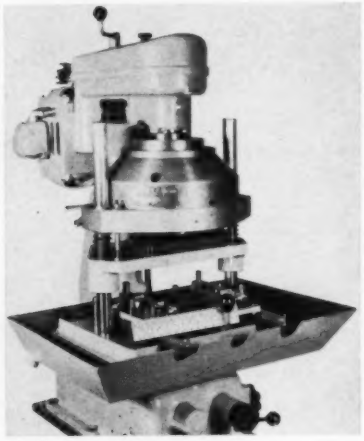
THE R. C. MAHON COMPANY • Detroit 34, Michigan

SALES-ENGINEERING OFFICES in DETROIT, NEW YORK and CHICAGO

Engineers and Manufacturers of Complete Finishing Systems—including Metal Cleaning, Pickling and Rust Proofing Equipment, Hydro-Filter Spray Booths, Dip and Flow Coaters, Filtered Air Supply Systems, Drying and Baking Ovens, Cooling Tunnels, Heat Treating and Quenching Equipment for Aluminum and Magnesium, and other Units of Special Production Equipment.

MAHON

breathe is provided. Direct feeding of the loading board from the hopper, with no restrictions from measuring devices or long feed tubes, and controlled vibration permit the use of a wide range of molding materials. Designed for preheating, the unit can be converted in the field for direct feed from the preheating unit. **F. J. Stokes Corp.**, 5500 Tabor Rd., Philadelphia 20, Pa.—*Circle 409.

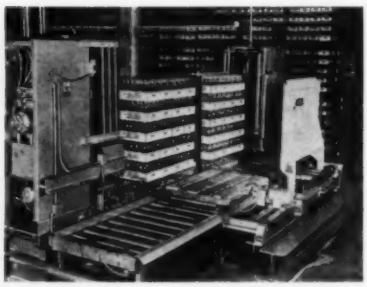


Small Drill Press

Item 414—Gearless drill head has been applied to a line of small drill presses which can be equipped with small diameter, medium duty drill heads. The table, which holds the part to be drilled, moves upward onto the rotating drills, being fed at a recommended rate to drill the holes. Travel of the table, feed into drills, and return travel downward of the table are automatic. The table carries an index fixture so that 25 spindles drill a total of 50 holes, 25 holes simultaneously in two passes. The table is actuated by hydraulic control, with a cylinder in the base. **Zagar Inc.**, 24000 Lakeland Blvd., Cleveland 23, O.—*Circle 414.

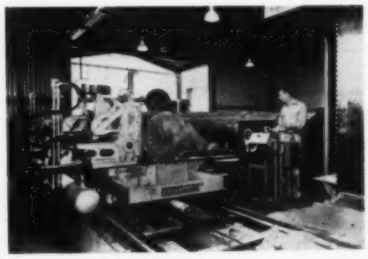
Pallet Loader-Unloader

Item 443—Available for stacking or unloading cartons, bottles and barrels, pallet loader - unloader which is designated Model 408000, consists of a case unstacker and a case stacker which have been integrated with the proper control



mechanisms into a completely automatic unit. In operation, a full pallet load of empty cases is deposited in the correct position by a fork truck. The rest of the unloading-loading operation is completely automatic.

The cases of empty bottles are unstacked and sent individually to the washer and filler lines. As the full cases are individually received from the filling machine, the loader-unloader builds stacks of cases, and palletizes them in noninterlocking patterns onto the same pallet which has been unloaded. The complete pallet load of filled bottles then moves into position for pickup by fork truck. The illustrated unit is capable of depalletizing 1200 cases of empty bottles per hour while simultaneously loading up to 1200 full cases per hour. **Packing Equipment Div., Food Machinery & Chemical Corp.**, Riverside, Calif.—*Circle 443.



Sawmill Carriage

Item 424 — Lightweight, aluminum sawmill carriage is completely air-operated and has 110v electric control. The remote controlled carriage, weighing less than one-half as much as a wood-steel model, is constructed of fabricated aluminum channels welded in tubular sections and aluminum castings. Steel wear plates and fenders are used at all points of wear and abrasion. The carriage wheels are cast aluminum with replaceable steel tires.

The carriage is 20 ft long with a 40-inch log opening. It carries a 10-inch by 18-ft aluminum air receiver tank. The carriage is driven by a Westinghouse log-carriage drive, rated 35 hp continuous with 70 hp peak. Speeds are arranged for normal sawing at 300 fpm, with a ceiling speed of 718 fpm for return. This arrangement provides a maximum of 12 round trips per minute. The drive consists of a low inertia dc motor operating on adjustable voltage from a magnetic amplifier regulator. It is capable of 20 round trips per minute for short lengths. **Enterprise Co.**, Columbiana, O.—*Circle 424.

Clip Feeder

Item 441—Developed for feeding and staking clips to automobile body moldings, automatic machine affords increased production and operator safety. The complete unit consists of a vibratory part feeder in which clips are oriented and fed to the staking device. The electro punch unit includes a device for depositing the clip and staking it to the automobile window trim. **Automatic Methods Inc.**, 875 W. Grand St., Elizabeth, N. J.—*Circle 441.

*For Inquiry Card, see page 17

Elevating Conveyor

Item 451—Short-length parts are elevated and fed automatically at any desired speed by Model 4500 elevating transfer conveyor. The machine accepts parts in a rolling position at a minimum height of 20 inches, elevates them to a maximum of 130 inches and feeds them into a production machine, assembly line or packing unit. Range of work includes elevating transfer of piston pins, tappet bodies and similar parts.

The conveyor is equipped with a variable speed drive and has a timing take-off from the cam mounted on the lower shaft. Power is furnished by a ¼-hp 220/440 v motor. **Feedall Inc.**, Willoughby, O. —*Circle 451.

Projection Welder

Item 425—Developed to improve the efficiency and reduce the costs of manufacturing automatic transmission components, automatic machine projection welds four studs to a cover rather than by mechanically locking them. A feature of the welder's performance is its ability to hold close tolerances. The location of the four studs is held to ±0.012-inch between centers.

The welder has an automatic unloading and part turnover device which feeds the complete welded part to the inspection station, prior to machining. Operation of the machine is automatic following manual loading of four

*For Inquiry Card, see page 17

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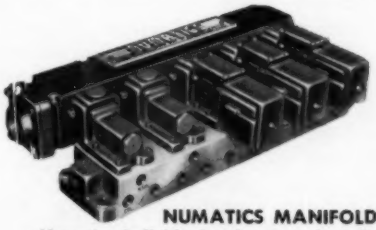
. . . there are no "equivalents"

In a momentary contact valve application, safety . . . for operator and machine alike . . . depends on a valve that will not shift when de-energized. Numatics DSA4 valves *can't* shift. Numatics exclusive detent does the trick . . . it safely, positively locks the valve spool in position the split second the valve is de-energized. What's more, this locking action is independent of air pressure, friction or packing drag. Numatics momentary contact air valves are, *in fact*, safer, more dependable than any other valves currently on the market. Write for complete information today.



NUMATICS MANIFOLDS
Numatics individual exhaust and conduit manifolds provide perfect "running mates" for Numatics solenoid actuated valves.

4-WAY HAND VALVES
For the utmost reliability and versatility, look first to Numatics 4-way hand valves. 136 models in 4 pipe sizes, a valve for every application.

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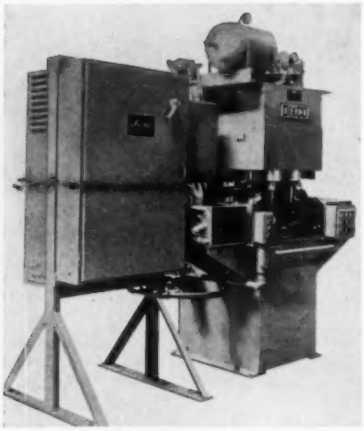


studs in the lower electrode and placing the stamping in the holding fixture. Rated output is 180 welded parts per hour at 80 per cent efficiency. The welder is rated at 260 kva, employing four 64 kva resistance welding transformers at 440 primary input voltage. **Dix Engineering Co. Inc.,** 1415 Dix Rd., Lincoln Park 25, Mich.—*Circle 425.

Metal Trough Conveyor

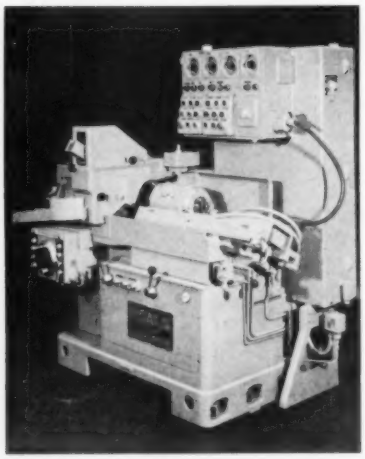
Item 453—Used for conveying liquids, chips, scrap, stampings, hot and cold forgings, castings, sand, grain, chemicals, powder, etc., metal troughing conveyor features hingeless construction. Food and corrosive materials can also be conveyed by using stainless steel troughing buckets.

Length, width and shape of the conveyor can be adapted to suit individual applications. The unit is available in portable and stationary models, with load rolling on rolls. Minimum height from the floor is 14 inches. **R. T. Sheehan Co.,** P.O. Box 345, Plymouth, Mich. —*Circle 453.

Internal Grinder

Item 422—Designed for small to medium work requiring precision internal size and finish, such as antifriction bearings, retainer rings, gear blanks, refrigerator compressor rolls and bushings, "Rite-Angle" automatic grinder is available in two models. Model 190A is used for straight and taper boring; ball track grinding is performed by model 1901A.

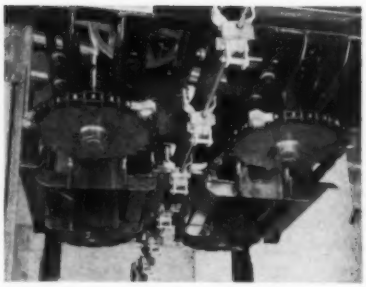
Designed with the wheelhead table inclined at an angle of 30 degrees to the work, the internal grinder features solid wheel backup to take heavy wheel pressure, true table tracking, good swarf and coolant drainage.



In operation, work is located and rotated on its own periphery against hard shoes and clamped against a rotating backing plate. Thrust forces against the wheelhead and table in heavy grinding are against the lower side of the gib or into a horizontal V-way. The lower way is a flat guide to keep the table straight. The inclined table construction allows clearance for various diamond dressing units and a simple adjustment for wheelhead height. **Heald Machine Co.,** Dept. 190, Worcester 6, Mass.—*Circle 422.

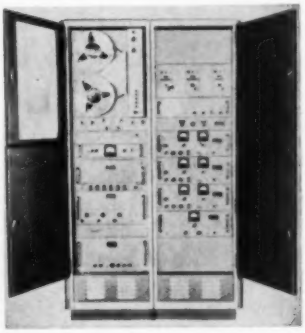
Cable Conveyor Drive

Item 437—Developed to increase the application of overhead cable trolley conveyors, caterpillar drive is used with Bush-Lock cable conveyors. Applied on the straight run of conveyors, the drive allows



large-radius traction wheel turns to be used. As a result, sizable loads can be handled on close hook centers.

The caterpillar drive has two strands of precision chain with special dogs that engage the cable and trolley with equal pressure from both sides. Side thrust is carried by both chains, so that cable movement is transmitted smoothly during engagement. There is no tendency for the trolley to cling to drive dogs on disengagement when using the double caterpillar feature. Drive sheaves are timed with bevel gears. Traction wheels of large radii guide the cable around idler corners and permit clearance of large packages. **E. W. Buschman Co.,** Clifton & Spring Grove Aves., Cincinnati 32, O.—*Circle 437.



Magnetic Tape Systems

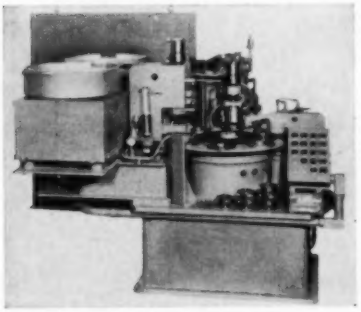
Item 442—Designed to meet the requirements of analog data recording needs, magnetic tape data recording system has a maximum of 15 tracks. Individual data recording requirements are met by selecting from standard transports, heads, and recording/playback electronics and combining these

*For Inquiry Card, see page 17

components in standard racks. Any of the tracks provided may carry data recorded by direct recording, FM recording and PWM recording techniques.

The standard transport offers six tape speeds. The transport is available for 1 or 1½-inch tape, on 10½ or 14-inch reels. In-line multitrack heads permit up to 15 tracks on 1½-inch tape and assure precise phase coincidence across the tracks. Interleaved head stacks permitting up to 30 tracks on 1½-inch tape are optional for telemetering and other applications not requiring data coincidence.

Standard direct recording electronics permit recording and playback of data from 100 to 100,000 cps. Accessories available for use with the tape system include servospeed control, voice recording and playback equipment, footage counters, tape loop idler assemblies, automatic rewind, restart equipment and remote control facilities. **Davies Laboratories Div., Minneapolis-Honeywell Regulator Co.,** 10721 Hanna St., Beltsville, Md.—*Circle 442.



Assembly Machine

Item 433—Designed to automatically perform multiple operations including press-fit inspection on automatic transmission gear carrier assemblies, eight-station machine handles 720 assemblies per hour. Four pinions with needle bearings and spacers for each are assembled into the gear carrier and held in place with dummy pins. Permanent pins are fed from two vibratory hoppers, shuttled into position, and pressed into the assembly, forcing out dummy pins. A

*For Inquiry Card, see page 17

If it's hard to hold...

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We designed and built the world's first automated gear chucks. These were successful immediately. Repeat orders, and production records covering millions of gears in high-production and contract gear plants alike, firmly established our reputation as the firm to see first on all jobs. This experience can be yours without cost or obligation. So—the moment the matter of automation arises—call on us. Let us engineer and build the quick-acting, trouble-free, accurate workholding fixtures which determine to some considerable extent the *output* and *quality* of parts that will be produced on your proposed automated machines.

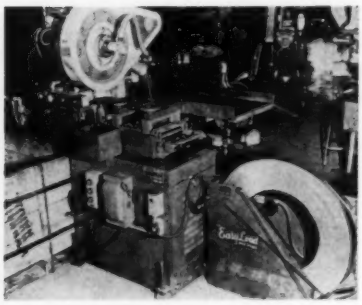
If you are not ready for the plunge into automation . . . we can furnish special holding fixtures for your standard machines that will help match the efficiency and production capacities of automated equipment. Send your prints. No obligation, of course.

GARRISON MACHINE WORKS, INC.
DAYTON 4, OHIO, U.S.A.

Circle 684 on Inquiry Card

predetermined pressure is applied to check the press fit of each pin. A memory circuit in the electrical system causes defective assemblies to be ejected.

The control panel has automatic *Start* and *Stop* buttons and buttons which control individual machine movements, also offering forward and backward inching control of the table. All stations are hydraulically operated and have complete electrical interlock. **Omer E. Robbins Co.,** 24800 Plymouth Rd., Detroit 39, Mich.—*Circle 433.



Coil Feeder

Item 408—Redesigned R series straightening and feeding machines allow for increased width capacity. Capacities of 10, 15, 20 and 24 inches are available, with thickness capacity in mild steel ratings ranging from 0.125 at 10-inch width to 0.045 at 24-inch width. The feed rate is variable from 18 to 95 fpm.

Feeding into a positive stop in the die produces identical parts and prevents the possibility of short feeds. The preselected feed length method is well suited for single-station dies on jobs which have a scrap skeleton between each part, or in cut-off operations where a slight length variation is permissible. The feed length selector is equipped with an indicating device which is instantly adjustable to change lengths from ½-inch to 5 ft on standard machines. Longer feeds are available.

On jobs requiring very long feeds, a stop limit switch may be mounted beyond the cut-off to be tripped by the end of the stock when the desired length has been fed. A fourth method, using a loop control arm for feeding into a slack loop on operations having an automatic feed on the press, is also available. **Rowe Machinery & Mfg. Co.,** 1506 N. Industrial Blvd., Dallas, Tex.—*Circle 408.

Magnetic Tape Truck

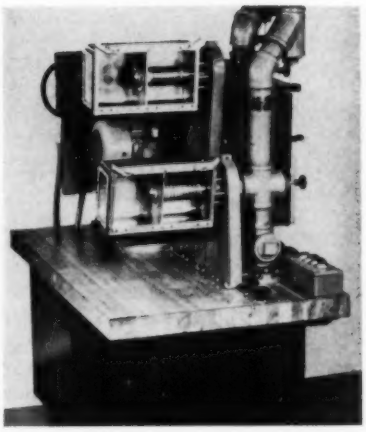
Item 435—Triple-duty magnetic tape truck protects, houses, and transports. The magnetic tape truck features mobility and practicability. A recessed accessory tray with two compartments is at one end; a handle and label holder for proper identification on the other. Each bin has its individual label holder. Extra housing is provided at the bottom.

Two basic truck units are available. One is designed with either two or four reel sections of 25 bins each, accommodating a total of either 50 or 100 eight-inch diameter reels. The other is designed to accommodate the same number of 11-inch diameter reels. All trucks are equipped with a locking device, one lock controlling one reel section of 25 bins. **Remington Rand Div., Sperry Rand Corp.,** 315 Fourth Ave., New York 10, N.Y.—*Circle 435.

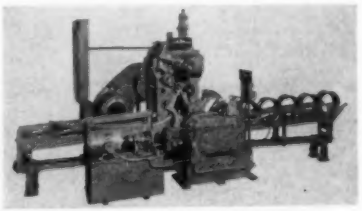
Automatic Loader

Item 412—Making use of the blow-loading principle of operation, Freeloader device makes possible completely automatic loading of a wide variety of parts. The machine can handle screw machine or stamped parts as well as parts fabricated by other methods. The device can handle almost any number of parts.

In operation, air pressure introduced into an oscillating loading drum forms a vortex at each orifice of the collecting pattern. As the drum oscillates, the parts pass back and forth through the vortices until they are drawn into place. When a part enters, it seals the orifice and remains in place until the air pressure is released. Loading is usually accomplished in 30 seconds to 3 minutes.



Three models are available: Model A-3, double drum, individual drives; Model A-2, double drum, single drive; and Model A-1, single drum, single drive. **Blow-Loading Div., Whitso Inc.,** Dept. ANC, 9330 Byron St., Schiller Park, Ill.—*Circle 412.



Wheel Rim Forming

Item 436 — Self-contained unit developed for automation in a wheel rim forming line is a series of three forming machines, with automatic load and unload mechanisms, electrically interlocked to form a continuous line.

In each machine of the unit, the wheel rim is guided through a gravity chute, and checked for proper position. When it reaches the load station, a signal energizes the *Feed Forming Machine* mechanism, and the wheel rim is in-

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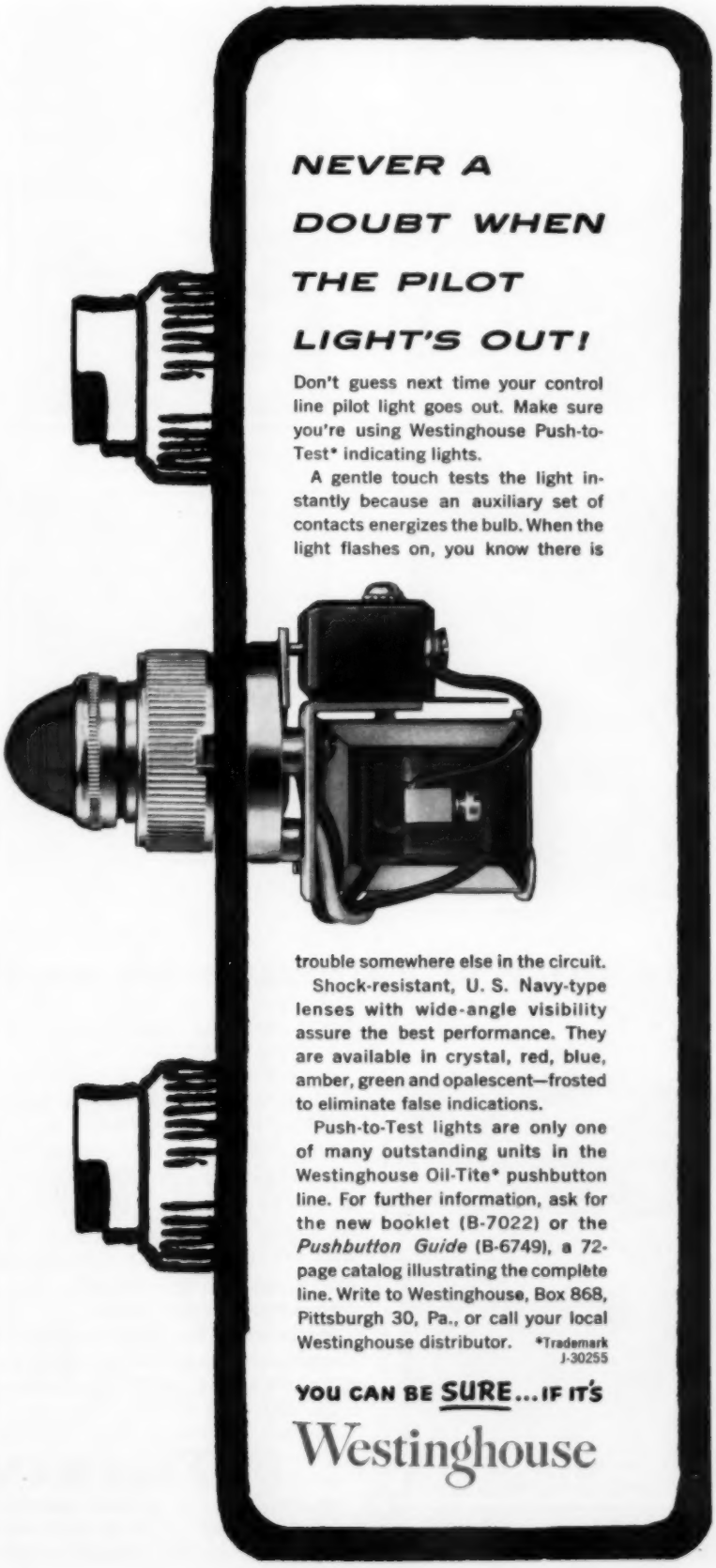
dexed to a position in front of the form roll. The lower form roll, over which the wheel rim has been loaded, raises to the upper roll and performs the forming operation. A guide mechanism maintains wheel alignment during the operation. The rim is lowered to the fixture and moved out to the index position. The formed wheel rim is ejected into a chute, while the next wheel rim is formed in the machine. **LaSalle Tool Inc.,** 3840 E. Outer Dr., Detroit 34, Mich.—*Circle 436.

Lifter-Dumper

Item 445—Designed to lift, upend and dump loads up to 400 lb, mechanical lifter-dumper handles 75 loads per hour. It can be equipped as a multipurpose machine with changeable skips for handling drums, barrels, boxes and bags. It is also available with one skip for a single-purpose operation.

The Cesco Jr. dumper models are made in sizes to dump at any height ranging from 2 to 8 ft. Special stationary models are built for dumping at any height required. Extreme heights are limited only by the distance to an overhead anchor. The dumper features standard pushbutton controls and a ¼-hp motor, three or single-phase. **Essex Conveyors Inc.,** 165 Franklin Ave., Nutley 10, N. J.—*Circle 445.

*For Inquiry Card, see page 17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Push-to-Test lights are only one of many outstanding units in the Westinghouse Oil-Tite* pushbutton line. For further information, ask for the new booklet (B-7022) or the Pushbutton Guide (B-6749), a 72-page catalog illustrating the complete line. Write to Westinghouse, Box 868, Pittsburgh 30, Pa., or call your local Westinghouse distributor. *Trademark
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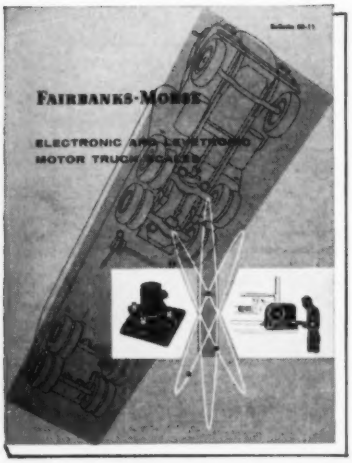
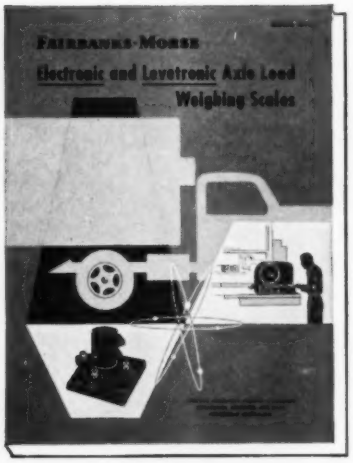
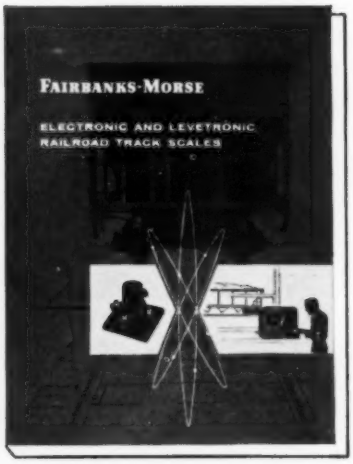
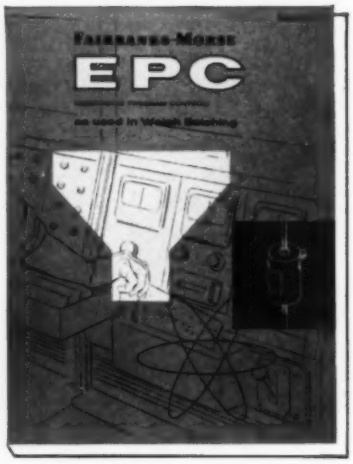
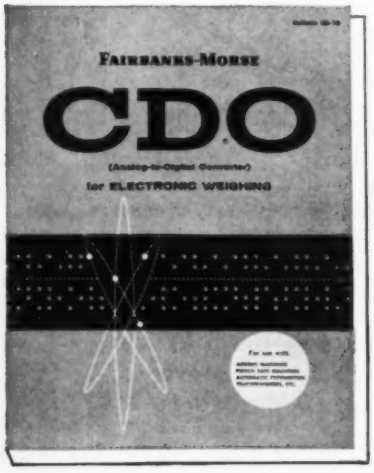








The story of Fairbanks-Morse Electronic Scales in seven volumes



Just off the press—seven new bulletins about Fairbanks-Morse electronic weighing and batching machinery. The covers pretty well identify themselves as illustrated above, except that you might not know that EPC is a completely automatic batching system that operates from punch cards . . . or that Batchetron is a slightly less automatic batcher with quick provision for manual preset of the cycle . . . or that CDO is a "read-out" instrument that will translate the weight message of any of the other six into the language "spoken" by automatic typewriters and automatic adding machines and automatic tape punches.

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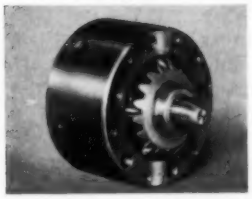


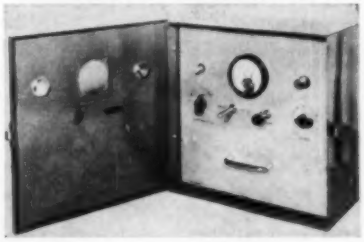
Automated Grinder Chuck

Item 499—Used on completely automated cylindrical grinding machine, bevel gear chuck is designed for an automobile differential side gear. The chuck locates the gear by minor diameter of internal splines and bevel teeth, insuring concentricity and uniform height of back face.

Chuck receives gear from the loading device, locates it accurately from splines and teeth for concentricity and proper backlash, and clamps the gear securely while the work spindle rotates. When grinding is completed, the chuck ejects the finished gear, picks up a new part and repeats the cycle. **Garrison Machine Works Inc.**, Dayton 4, O.—*Circle 499.

Control Valve

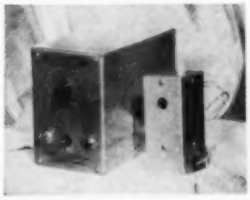
Item 516—Suitable for any application requiring a time delay between the release of the electrical impulse on the solenoid of the air valve and the return of the cylinder to its original position, solenoid-operated time delay air valve is an addition to the Hi-Cyclic line. The delay time is adjustable between 0 and 30 seconds, with a repetition accuracy of ±10 per cent. The time delay is built into the valve so that it requires no special switching to accomplish the time lag. Known as Model BVP-ATD, the valve is available in ¼ through 1-inch ports. **Beckett-Harcum Co.**, 1087 Wayne Rd., Wilmington, O.—*Circle 516.



Monitoring Unit

Item 514—Developed for the protection of automatic machinery against damage arising from load changes, electronic device is called the Monitron. The unit continuously monitors power drawn by any electrically driven machine. By sensing minute changes in operating loads and functioning within milliseconds, the Monitron stops a motor, releases a clutch or applies a brake very quickly, simultaneously signaling a warning.

The device senses load increases and decreases. Since the power drawn by a machine is proportional to the mechanical load, power changes beyond predetermined limits cause the Monitron to trip. At this time a warning light is illuminated and a relay energized to start any desired control function in auxiliary equipment. **Sperry Products Inc.**, Shelter Rock Rd., Danbury, Conn.—*Circle 514.



Photocontact Relay

Item 535—Developed for experimental, research, production control or safety applications, photocontact relay is designated Model 330. The unit is a double-pole, double-throw relay which will open or close any desired external circuit. It may be made to operate either by the interruption of a light beam directed at a photoelectric cell, or by the closing of a pair of contacts which may have resistance as high as 1 megohm, making it a dual-control unit. **Hunter Mfg. Co.**, 108 S. Linn St., Iowa City, Iowa.—*Circle 535.

Dial Timer

Item 544—Used for industrial processes, laboratory and machine automation, Atcotrol miniaturized dial type reset timer is a synchronous motor driven unit for control of ac or dc loads within variable timed intervals or sequences. Applications of the timer include vacuum metalizing, bonderizing,

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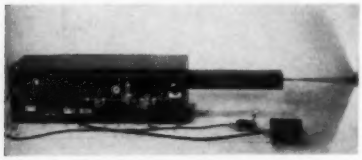
grinding, die casting, injection molding, automatic lubrication, conveyor systems, automatic batching, and packaging machinery. The timer controls up to six individual load circuits.

The dc model differs from the ac unit only in the clutch relay and the motor which are wound to accommodate the voltage of the particular application — operating voltages ranging from 6v dc to 250v dc in the former unit. **Automatic Temperature Control Co. Inc.,** 5200 Pulaski Ave., Philadelphia 44, Pa.—*Circle 544.



Die Lubricator

Item 500 — Electrically controlled, air-operated machine is designed to apply sprayable lubricants to dies. Lubricator is effective for presses, upsetters, die casting and glass molds.

In operation, the machine gets its signal from the press. The nozzle advances, sprays continuously over the face of the die, reverses still spraying, and returns. Lubricator features adjustable spray cycle and more than 5000-cycle per hour operation. **Columbus Automatic Lubrication Co.,** P. O. Box 1145, Columbus, O.—*Circle 500.

Position Sensor

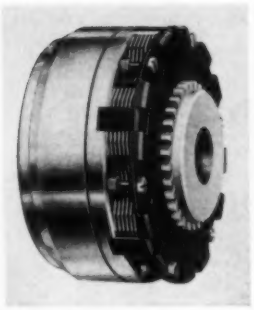
Item 501—Designed to detect the correct position or size of metallic objects without contacting them, SCI 400 electronic sensing control can be used to check proper positioning, check proper size and shape, detect moisture change, detect ionization change in liquids, etc. The control is set up to any given constant, at a given time interval, and then recognizes deviations from the constant. It also indicates how the sensed object is wrong. The control then either stops the machine, rejects the object, or actuates correcting mechanisms. It senses either ferrous or non-ferrous objects.

Sensing element is surrounded by protective insulator material, and is unaffected by vibration, dirt and abuse. **Security Controls Inc.,** 257 Franklin St., Buffalo 2, N. Y. —*Circle 501.

Pressure Cell

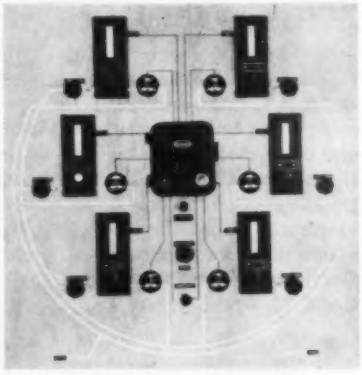
Item 517—Applicable in industrial measurement, and particularly suited for wind tunnel work in which it replaces banks of manometers which require tedious photographs and manual data reduction, differential pressure cell for measuring fluid pressure is designated as the FMM model. The unit is one of a series of SR-4 strain gage pressure cells which measure pressures of fluids ranging from human blood to gases in rocket chambers.

Features of the unit include three capacities of differential pressure: ±15, 30 and 60 psi; line pressure to 90 psi; increased output to 3 mv/v; linearity and calibration accuracy up to 0.1 per cent full scale; and a 240-ohm bridge, permitting higher input. The analog signal of the cell is used in any type of indicating, recording or controlling instruments and is convertible for analog-to-digital computation. **Dept. HN 18, Electronics & Instrumentation Div., Baldwin - Lima - Hamilton Corp.,** Waltham, Mass.—*Circle 517.



Magnetic Clutch

Item 497—Complete torque control under all rated conditions through pushbuttons, relays or limit switches is provided by magnetic clutch. Unit is easily adapted to modern machine tools with a wide range of bore sizes. Fast operating speed in both engagement and disengagement, reduced decay time and residual drag by effective isolation of the magnetic assembly from the clutch friction components, are features of the magnetic clutch. **Fawick Airflex Div., Fawick Corp.,** 9919 Clinton Rd., Cleveland 11, O.—*Circle 497.



Automatic Tank Selector

Item 503—Developed for controlling the filling of storage and settling tanks, automatic tank selector system is applicable to the petroleum, chemical and related industries. In operation, the tank selector controller automatically senses the liquid level of each tank in the system through the level transmitter, then automatically opens the fill valve if the tank re-

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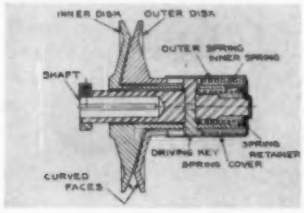
quires filling, or automatically cycles to the next tank if filling is not required.

Scanning operation can be continuous or intermittently cycled as needed. Each circuit can handle up to 12 tanks and two or more selectors can be connected in series to control any number of tanks. **Dept. ATS, Mason-Neilan, Div., Worthington Corp.,** 60 Nahatan St.. Norwood, Mass.—*Circle 503.

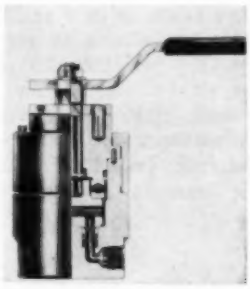
Precision Switching

Item 525—Plastic body precision switches can be grouped together in any numbers to perform multiple switching functions in confined areas. Switches are small enough to permit fitting nine of them in 1 cu inch of space. Characteristics of the 5000 Series switches are 5 amp resistive at 28v dc; 5 amp resistive at 115v ac. They are operative between −65 and 250F. **Haydon Switch Inc.,** Waterbury, Conn. — *Circle 525.



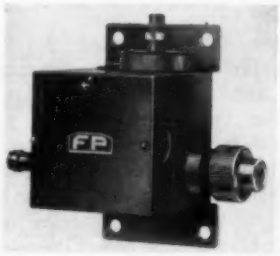
Variable Speed Pulleys

Item 519—Planned to compensate for variations in production schedules or differences in the ability of operators, variable speed pulleys have a speed ratio of 2½ to 1. Oil-impregnated bronze bushings eliminate need for lubrication. Units can be installed on old or new equipment. Pulleys are available in two models: Model No. 175 is rated at 2/3 hp at 1150 rpm and 1 hp at 1750 rpm; No. 180 at 1 hp at 1150 rpm and 1½ hp at 1750 rpm. **Lovejoy Flexible Coupling Co.,** 4984 W. Lake St., Chicago 44, Ill.—*Circle 519.



Shut-off Valve

Item 522—Designed for a burst pressure of 40,000 psi, shut-off valve is rated for liquid or gases of 10,000 psi and will withstand surges up to 15,000 psi. Valves can be furnished for pipe, tube, or any special high pressure connection. **Barksdale Valves,** 5125 Alcoa Ave., Los Angeles 58, Calif.—*Circle 522.



Controlling Cell

Item 551—Means for controlling oxidation-reduction processes is provided by O-R-P cell. The unit is sensitive to changes in the relative concentration of specific chemical ingredients in liquid vehicles; such changes affect the electrical potential between the inert metal electrode and a reference electrode.

The cell operates at pressures up to 35 psi and may be obtained alone or in combination with an F&P self-balancing potentiometer. Cell and potentiometer, in conjunction with electric, electronic or pneumatic controlling devices, can regulate either batch or continuous flow processes.

A feature of the cell is its straight bore design which gives an unrestricted flow stream, eliminating deposits and plugging. Contamination of the reference electrode is prevented by a reservoir pressure of from 2 to 5 psi greater than that of the static pressure in the cell itself. **Fischer & Porter Co.,** 2000 Jacksonville Rd., Hatboro, Pa.—*Circle 551.

Digital Voltmeter

Item 508—Accurate measurement of low level dc voltages from thermocouples, strain gages and transducers is provided by digital voltmeter which also displays the information numerically in illuminated panels. Designated Model 460, the device does not require a preamplifier, and does not use potentiometers or slide wires. A sealed oil bath eliminates the need for periodic disassembly for lubrication and keeps dust and moisture from the switching mechanism.

The voltmeter provides for connection and automatic print control for operation of Clary printers and the IBM summary punch. It is also available in complete data recording systems utilizing printers, tape punch and electric typewriters. Other accessories include multichannel input scanner and remote digital readouts.

Applications for the device including reading and recording outputs of strain gages, thermocouples, and other low level transducers, automatic data logging systems, industrial processing monitoring, automatic testing systems and the calibration of other voltage measuring, recording or plotting devices. **Non-Linear Systems Inc.,** Del Mar, Calif.—*Circle 508.

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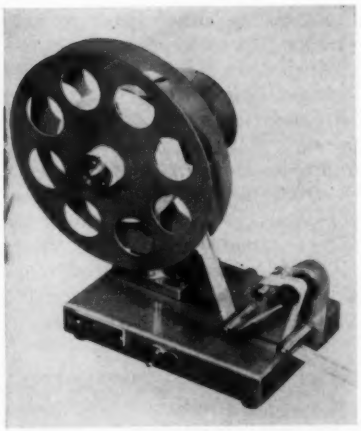
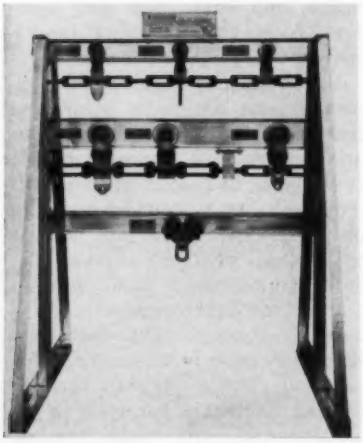


Tape Handling Equipment

Item 498 — Winder for common language tape can be used in integrated data processing, communications, automation, computers, and high-speed perforators. Tape winder adjusts automatically to output speeds from 0 to 240 lines per second at the core and adjusts instantly to tensions required, from ½ to 15-inch oz. Unit operates unattended for long periods; starts, stops, winds slow, fast or intermittently at the command of the output. Reels are available in 8 and 12-inch sizes. **Whiteford Laboratory,** 420 Market St., San Francisco 11, Calif.—*Circle 498.



Conveyor Trolleys

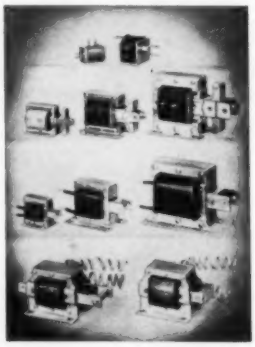
Item 518—Used on I-beam suspended conveyor systems, line of ball bearing trolleys is designed for long, dependable service. Hardened tread, hardened and ground races and caged ball bearings give smooth, low friction operation. Protected grease fittings and three baffle type grease seals allow efficient lubrication and minimum maintenance.

The ball bearing trolley assemblies are available in 4 and 6-inch models. In addition to standard trolleys, the line includes special designs of "lubricated for life," heavy load—light pull, and heavy duty attachments. **Anchor Steel & Conveyor Co.,** 6906 Kingsley Ave., Dearborn, Mich.—*Circle 518.

Signal Generator Unit

Item 509—Designed for the measurement, indication, transmission and control of a variety of process variables including pressure, differential pressure, flow, liquid level and temperature, ElectroSyn system is applicable to the natural gas, petroleum, chemical processing and atomic power industries. Infinite gain at zero frequency affords a high degree of accuracy. Long life is provided by electromagnetic transducers and magnetic amplifiers.

The system is composed of three basic components: A signal transmitter (transducer), a power unit (magnetic servoamplifier), and a null-balance indicating receiver. In measuring pressure, differential pressure or flow, the signal transmitter converts the process variable into a shaft rotation of the ElectroSyn, a rotary differential transformer. Output from the transmitter is an ac voltage exactly proportional to the variable (12v full-scale). When measuring temperature, the signal transmitter is simply a temperature-sensitive resistor and the ElectroSyn is replaced by a precision potentiometer. **Norwood Controls, Unit, Detroit Controls Corp.,** 934 Washington St., Norwood, Mass.—*Circle 509.



Custom Solenoids

Item 545—Line of custom-designed solenoids consists of 17 models to provide 34 different specifications. Push and/or pull capacities range up to 45 lb; sizes from 1⅜ by 1⅜ to 3 by 3 inches, and stroke lengths from fractional to 2 inches are available.

Double shading coils provide high sealed pull without hammer or excessive ac hum. The units are engineered to close tolerances. **Dormeyer Industries,** Dept. ANC, 3418 N. Milwaukee Ave., Chicago 41, Ill.—*Circle 545.

Vacuum Cups

Item 536—Suited for turn-over applications, transfer of stampings and stacking of all types of products from containers to plate glass, vacuum cup is designed for product handling. The cup is composed of pliable, molded neoprene vulcanized to an aluminum or cast iron plate. By attaching the units to operating arms and installing vacuum lines, the cups can be

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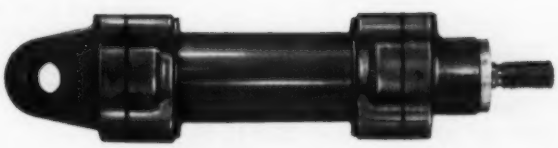
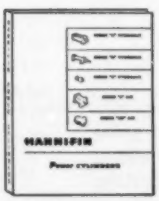
HANNIFIN

POWER CYLINDERS



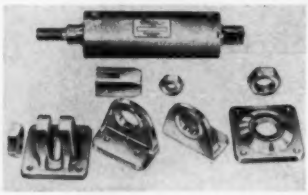
COMPLETE CYLINDER FILE

Write for your copy of this new Hannifin Cylinder File...complete, easy-to-use, easy-to-order-from information on five lines of Hannifin cylinders. Write Hannifin Corporation, S. Wolf Road, Des Plaines, Illinois.



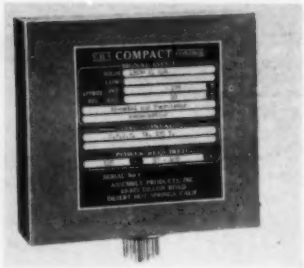
Circle 687 on Inquiry Card

used to pick up a wide variety of products. Ribbed section in the center of the cup assures maximum vacuum even on irregular surfaces, and prevents any tendency for the cup to collapse. Cups are stocked in two styles and four sizes, 3, 4, 5, and 6½ inches. **Stilson Tool Co.,** 30233 Groesbeck Highway, Roseville, Mich.—*Circle 536.



Compact Cylinders

Item 529—Designed for air or hydraulic service to 200 psi, compact cylinders come in 1½ and 4-inch bore sizes. Units feature internal feed-ring locking of heads to cylinder barrels, eliminating bulky head castings. Flange, clevis or L-type mounting brackets are interchangeable. Construction is non-corrosive; barrels are of hard-drawn seamless brass tube, rods of ground and polished stainless steel, heads and pistons of aluminum. Industrial O-rings are used throughout. **Modernair Corp.,** 400 Preda St., San Leandro, Calif.—*Circle 529.



Thermocouple Control

Item 533—Contained in a single compact package, Series 2300 thermocouple temperature control with automatic or limit control action consists of a high sensitivity meter relay and load relay together with control components. Limit types trip a relay and lock, and must be reset externally. These may be used for temperature monitoring or alarm. Automatic types include an automatic interrupter for periodic reset; they can control heaters or coolers. Also available are low-limit and high and low double-contact models for detecting any change in temperature. Temperature range is −400 to 3000F, and −240 to 1650C. **Assembly Products Inc.,** P.O. Box XX, Palm Springs, Calif.—*Circle 533.

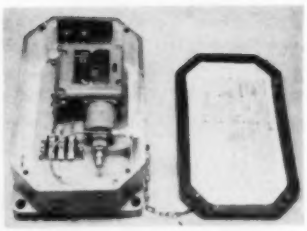
Power Supply

Item 515—Developed for use in high production precision welding, dc stored energy power supply is designated Model 18A. Rated at 18 watt-seconds, the power supply is equivalent to a 5.8 kva ac system, but the use of the stored energy principle eliminates the need for high current capacity power lines.

Welds at rates up to 250 per minute are possible with the device, which can also join metals of high electrical or thermal conductivity. Adjustments include a heat control varying between 425 and 1150 v, and a weld time control for long or short welds. All-electronic operation assures accurate control and uniform welding of such components as vacuum tubes, relays, precision instruments, contacts, etc. **Commercial Equipment Div., Raytheon Mfg. Co.,** Waltham, Mass.—*Circle 515.

Lubrication Unit

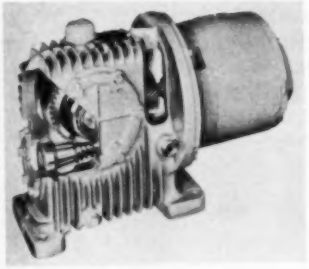
Item 527—Designed to stop machinery when the lubrication pressure drops below a predetermined setting, Cyclesafe unit provides



protection against automatic lubrication failure. The machinery completes the working cycle before stopping, eliminating tool, cutter, die or knife damage or breakage. It cannot be restarted until the failure has been corrected and pressure restored. **Seneca Falls Machine Co.,** Seneca Falls, N.Y.—*Circle 527.

Worm Gearmotors

Item 541—Available in both standard extended shaft and shaft-mounted models, permitting a wide degree of installation variation, line of right-angle worm gearmotors uses double-enveloping worm gearing. Four sizes are available to handle fractional to 15 hp motors; the range is being extended to 40 hp. The gearmotors are available in 28 standard output speeds from 6.25 to 525 rpm in both extended shaft and shaft-mounted models.



Use of cooling fins provides maximum cooling area and housing reinforcement. Neither ratio nor number of teeth affects the total contact area or strength of the gearing. All teeth within an arc of 45 degrees on the gear are in simultaneous contact with threads on the worm. **Cone-Drive Gears Div., Michigan Tool Co.,** 7171 E. McNichols Rd., Detroit 12, Mich.—*Circle 541.

*For Inquiry Card, see page 17

Now--CONTROL offers you standardized saturable reactors

If you're a design engineer who would be delighted with industrial components which are sensitive and, under normal operation, last virtually forever with no maintenance or servicing, then you'll welcome CONTROL's *standard* lines of saturable reactors.

With CONTROL reactor assemblies and magnetic amplifiers, you know complete physical and operating characteristics —a copy of our Catalog R-10 awaits your request. And, delivery is fast because sub-assemblies of these units are stocked, awaiting your control-winding specifications.

CONTROL reactors are available for both 120- and 240-volt 60-cycle operation. There are eleven standard sizes in each voltage range. They have extremely high gain. Six ampere-turns control nearly 2,000 watts in the largest size. Power outputs range from 50 to 2000 watts, with only 2 ampere-turns required for control of the smallest units.

In addition to higher gain, smaller exciting current, and fewer ampere-turn characteristics, CONTROL reactors have a 40 to 1 cut-off ratio. They are totally enclosed so that the high performance toroidal cores used are protected, and the entire assembly has the ruggedness required for long life.

CONTROL offers the same convenience of standardization in use of high permeability magnetic devices that you've enjoyed with other components. Add to this convenience ruggedness and freedom from maintenance which is unmatched, and you'll welcome CONTROL to your design picture. Write for complete details and literature today. *CONTROL, Dept. A-37, Butler, Pennsylvania.*

Reliability begins with CONTROL

A DIVISION OF MAGNETICS, INC.

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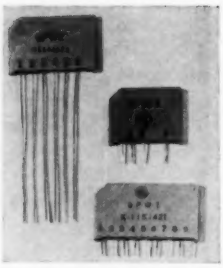
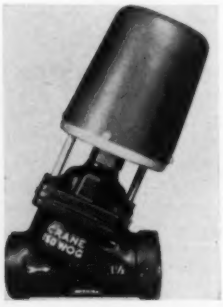


Enclosed Networks

Item 530—Adaptable to automatic placement, and designed for high humidity resistance, line of resistor-capacitor networks features a network plate encapsulated in an epoxy resin inside a molded, nonporous phenolic case.

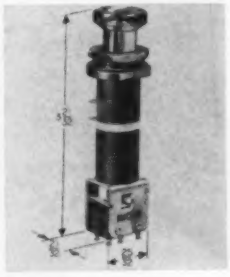
An index chamfer on the upper left corner of the case facilitates magazine loading for automatic placement. The networks are available in three case sizes, and the resistor and capacitor patterns and lead arrangements are provided to user specifications. The units have such radio and TV receiver applications as coupling, pulse-forming, and *R-C* filter networks. The operating temperature range of the networks is from 10 to 85C. **Specialty Electronic Components Dept., General Electric Co.,** Auburn, N.Y.—*Circle 530.



Valve Controller

Item 540—Remote or automatic valve operation with proportional or *On-Off* control is provided by all-electric rotary valve controller. Called the Valvetrol, the unit is a self-contained gearmotor with hollow output shaft that receives the valve stem. The controller incorporates a built-in potentiometer which may provide remote indication of valve position or which may be used as a part of a balanced bridge control. Typical application of the latter is the use of the Valvetrol in automatic proportioning systems where the valve setting must be proportioned to a signal that may originate from liquid level, flow rate, pressure or other source.

The Valvetrol is mounted with a hex stock adaptor so that the valve can be turned by wrench in the event of power failure. Selective gear ratios to the potentiometer adapt the unit to valves having anywhere from 1/6 to 40 turns to open full. **Jordan Co. Inc.,** 3235 W. Hampton Ave., Milwaukee 9, Wis.—*Circle 540.

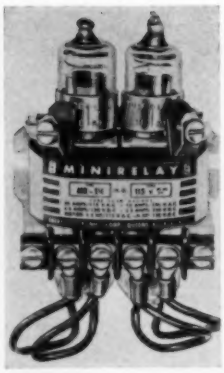


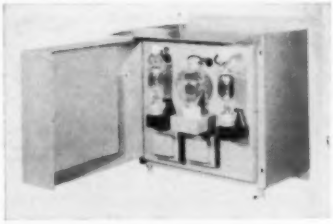
Lighted Switch

Item 507—Dual-purpose lockdown device is an addition to a line of illuminated pushbutton switches. The lighter switch functions as a conventional pushbutton type when pushed straight down. When pushed and turned approximately 20 degrees clockwise, the switch is maintained in the operated position. When turned counterclockwise from this position, the switch moves up to unoperated position. Designated 52PB7-T2, the switch can take the place of an alternate-action pushbutton and also provide optional momentary action. A subminiature bulb, independent of the switch circuit, illuminates the switch's translucent bottom. **Micro Switch, Div., Minneapolis-Honeywell Regulator Co.,** Freeport, Ill.—*Circle 507.

Mercury Plunger Relay

Item 542 — Created for power control applications where the use of a double-pole single-throw relay is advisable or required because of space, circuitry or economy factors, tiny mercury plunger relay is designated MR-14 Mini-Relay. Each contactor tube of the unit is rated at 1.5 hp or 20 amp at 115v, 10 amp at 230v and 5.2 amp at 440v, ac. In dc operation they are rated for loads up to 6.5 amp at 120v and 3.5 amp at 200v, or 1/3 hp. Any combination of normally open or normally closed contacts is available. Size of the MR-14 is 1¾ inches deep by 2⅜ inches wide by 4½ inches high. **Ebert Electronics Corp.,** 212-30K Jamaica Ave., Queens Village 28, N.Y.—*Circle 542.





DC Drive

Item 546—Electronic control of dc motors from ac power is provided by electronic adjustable speed dc drives. The units are available in sizes from ¾ through 3 hp. The speed range is 50 to 1 in any desired speed from 35 to 1750 rpm. No tachometer is required for any size unit; the drive motor functions as a tachometer.

The drives are available as complete packages, consisting of an anode transformer, a panel, a control station and a dc shunt wound drive motor. Drives are applicable

*For Inquiry Card, see page 17

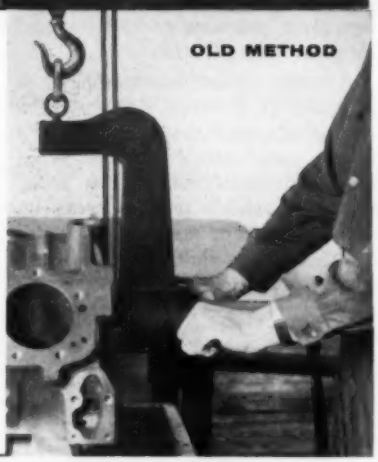
NEW TAFT-PEIRCE COMPAIRAMATIC

Checks 26 Dimensions at once!

Air Gaging and workhandling combined for Push-Button Gaging Crankshaft and Camshaft Bores, and Presence of Oil Holes in V-8 Engine Blocks.

NEW METHOD

Gaging Cycle: CompAIRamatic is push-button controlled by one operator with safety-interlock that requires operator's hands on controls during gaging cycle. V-8 Block moves along conveyor to CompAIRamatic where it goes into position against pneumatic stops. Operator presses cycling button that elevates gaging heads and moves them laterally into camshaft and crankshaft bores. All 26 dimensions are shown simultaneously between tolerance marks on indicators mounted in cabinet. Gaging heads are retracted and the block goes on its way. There is no risk of jamming due to undersize work dimensions because of automatic shut-off controls.



OLD METHOD

Here is a semi-automatic air gaging unit that replaces multi-step, time consuming quality control with a single, low-cost operation.

Problem: Long, counterbalanced air plug gage on hoist had to be centered and inserted through camshaft bores by the operator. Another air plug gage was required for crankshaft bores, while another gaging method was used for checking presence of oil holes. Although gaging was accurate, the operation was inefficient and tiring for the operator.

Solution: Taft-Peirce developed this 26-dial CompAIRamatic that simultaneously indicates: 1. 5 cam bore diameters in two planes within .0015" total tolerance. 2. 5 crank bore diameters in two planes within .002" total tolerance. 3. Cam counterbore within .0005" total tolerance. 4. Presence of oil hole reservoir in 5 cam bores (using patented Taft-Peirce Comp-Utair Air Gaging Circuit).

Bring new cost savings to your quality control. Let Taft-Peirce help you engineer new air gaging concepts into your production line — from single dial units to multi-dial air-electric units for fully-automatic operations. Contact your nearest Taft-Peirce representative or write Taft-Peirce Manufacturing Company, Woonsocket, R. I.

Free Booklet "6 Special Ways to Air Gage For Lower Costs, Higher Production" shows typical T-P CompAIRamatic installations. Write for your copy.

TAKE IT TO TAFT-PEIRCE

THE TAFT-PEIRCE MANUFACTURING CO., WOONSOCKET, R. I.

T-P Means TOP Precision

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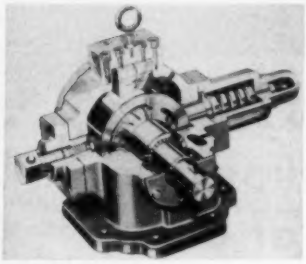
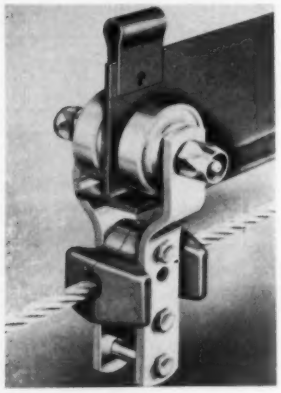
in such production operations as continuous processing, batching, feeding, conveying, testing, etc. **Weltronic Co.**, 19500 W. Eight Mile Rd., Detroit 19, Mich.—*Circle 546.



Hydraulic Pump

Item 512—Well suited for use in machine tool feed systems, hydraulic presses and mobile equipment, variable volume hydraulic pump is known as Model R. The device is designed for 1000 psi continuous operating pressure and 1250 psi at intermittent operation.

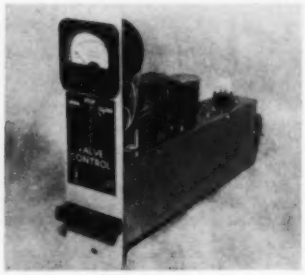
A volume selector adjustment is provided as standard equipment to manually adjust the pump delivery to the exact circuit requirements. Automatic selection of two separately adjustable pressures can be obtained by the use of hydraulic or electrically controlled pressure compensating pump governors. **Racine Hydraulics & Machinery Inc.**, Racine, Wis.—*Circle 512.



Heavy Duty Trolley

Item 524—Equipped with wheels featuring pressure lubrication, a special nut to protect the grease fitting, an enclosed back and a felt hub seal, heavy duty trolley is designed for applications involving industrial washers, paint spray booths and other operating conditions where excessive dust, moisture or temperatures are encountered.

Model T-10 trolley has wheels equipped with eight precision ball bearings running on a hardened inner race. Unit is available in two and four-wheel models, with nominal capacities of 250 and 355 lb respectively. **E. W. Buschman Co.**, Clifton & Spring Grove Aves., Cincinnati 32, O.—*Circle 524.



Indicator-Controller

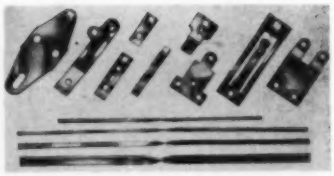
Item 496—Operation and position-indication of remotely located valves, gates, and feeders is possible with indicator-controller. Unit permits the remote modulation and continuous indication of valves or similar devices. This is accomplished through the transmitter package (illustrated) which has a three-position switch mounted on its face to control the device.

At the receiving end, another packaged unit contains the control relays and the regulated dc voltage supply used to transmit the position indication. **Builders-Providence Inc., Div. B-I-F Industries Inc.**, Providence, R.I.—*Circle 496.

Electrical Contact Tape

Item 502—Facilitating the assembly of component parts into one integral unit, electrical contact tape is used to form contact assemblies. The tape introduces automation to the manufacture of contact assemblies by permitting machine feeding of contacts through the welding process.

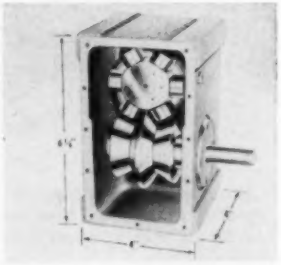
Tape is preformed to finished



shapes with close tolerance limits. This shape is maintained during the assembly process. Clad electrical contact tape assemblies require less contact volume for required electrical and thermal values. They are rolled to finished form and normally supplied with a serrated base metal backing to facilitate welding. **General Plate Div., Metals and Controls Corp.**, Attleboro, Mass.—*Circle 502.

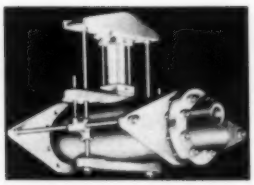
Roller Gear Drives

Item 543 — Designed for the packaging, photographic, pharmaceutical and instrumentation fields and other industries with applications for high indexing speeds and low torque requirements, E series roller gear drives are rated for 2000 indexes a minute. Components of the mechanism consist of a precision cut, hardened tool steel cam with a tapered rib and hub with standard bearing followers.



Two followers are in contact with the cam rib at all times. As the cam rotates, a curved portion of the rib indexes the hub and output shaft. When the followers reach a straight section of the rib, dwell occurs and the hub is locked with a precision of 0.001-inch and zero backlash without auxiliary locking or locating methods. **Roller Gear Div., Ferguson Machine Corp. of Indiana**, P.O. Box 5841, St. Louis 21, Mo.—*Circle 543.

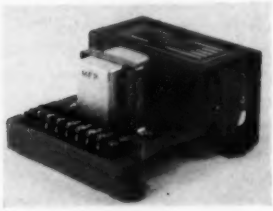
*For Inquiry Card, see page 17



Pinch Valve

Item 506—Used for handling abrasive and corrosive pulps and liquids, pinch valve is available with either rubber or neoprene sleeves, in sizes from 1 to 14 inches ID, for pressures to 150 psi, and temperature to 200 degrees F. A feature of the valve is the Hydral-Air operating mechanism which consists of an air-hydraulic pump and can be installed as a centralized unit for operating several valves. It can also be equipped for automatic regulation where it is essential to control liquid level in tanks or the rate of flow in pipe lines.

Other operating mechanisms include a torque arm reducer for manual operation, and a motorized unit. Remote control is possible on all three types of mechanisms. Recesses molded into opposite sides of the sleeve interior serve as hinges during compression. **Mine & Smelter Supply Co.**, 3800 Race St., Denver, Colo.—*Circle 506.

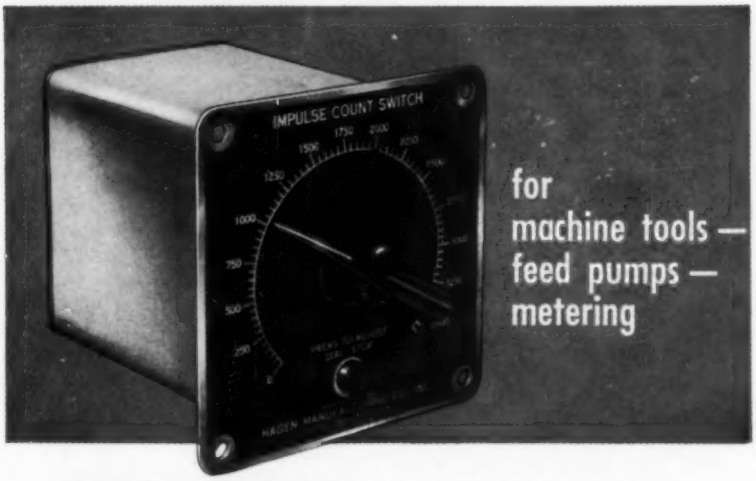


Monitoring Unit

Item 548—Fail-safe voltage and/or frequency monitor features sensitivity, precision and speed of response which make it a good voltage regulator as well as a close-differential relay. Called the Regohm, the unit is a close-differential device which can be used in a number of open loop or closed loop circuits to energize or de-energize ordinary relays or other control or signal devices when the

*For Inquiry Card, see page 17

HAGEN count switch



PAID FOR BY SAVINGS MADE ON JUST 1 TOOL

Simply set this Hagen Count Switch to the number of operations at which a tool should be changed. The count switch trips a switch after a preset number of electrical impulses . . . and thereby shuts down the machine automatically. Tool wear never reaches the point where tools must be ground down excessively to resharpen. That means increased tool life, reduced tooling costs and fewer rejects. Compare the savings on just *one* tool with the cost of this reasonably priced Hagen Count Switch. Chances are, the savings will be much greater.

This Hagen Model 70 Count Switch has 72 dial divisions . . . 72 possible settings. Dials are available with up to 54,000 counts. Accuracy: 1% of full scale range. Ideal for feed pumps and metering operations. Send coupon for Bulletin 780 — or data on the complete line of reset and repeating cycle timers and counters, interrupters and control assemblies.

MAIL COUPON TODAY!

HAGEN MANUFACTURING COMPANY, INC.
Dept. A-757, Moline, Illinois

☐ Please send free Bulletin 780 on Hagen Count Switch.

☐ Send free data on counters, timers, interrupters and control assemblies.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

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voltage being monitored exceeds or falls below certain values.

The variety of available types and coil current ratings makes possible a large number of voltage monitoring and control circuits. Regohms are made with either normally open or normally closed fingers. **Electric Regulator Corp.,** Norwalk, Conn.—*Circle 548.

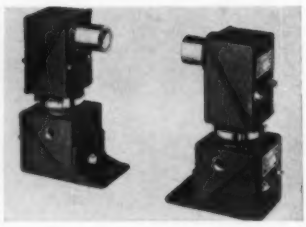
Stepping Switch

Item 532—Suited for use in airborne operations, experimental rocket and missile projects, in hazardous locations and wherever hazardous atmospheric conditions prevail, indirect drive Type 45 rotary stepping switch is available as a completely wired, hermetically sealed unit. The switch delivers an expected life production of more than 10 million sweeps across the bank.

Designed to afford a self-contained atmosphere for the switch, the sealed unit is sturdy enough to withstand a high degree of environmental shock and vibration, and provides the unit with up to twelve 25-point levels or eight 50-point levels. A maximum of 462 connectors can be brought out through one 14-pin header and sixteen 28-pin headers. The 14-pin header is used for off-normal, interrupter and coil wiring. One 28-pin header is used for each physical level. **Automatic Electric Sales Corp.,** 1033 W. Van Buren St., Chicago 7, Ill.—*Circle 532.

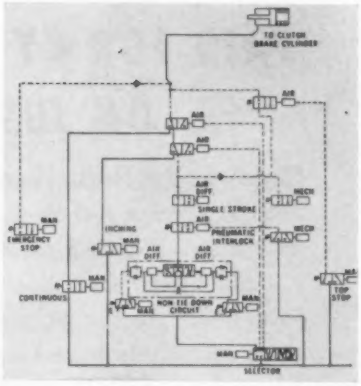
Photoelectric Controls

Item 539—Rapid replacement of photoelectric controls or light sources is afforded by plug-in mounted controls. Sockets are built into separate mounting bases. Controls and light sources plug into the bases and are secured by snap-action clamps. The sockets swivel for precision alignment. A



soft neoprene gasket seals out dust. Replacement requires no special tools.

Dark and light-actuated photoelectric controls, photoelectric timing controls and an entire series of light sources are available with plug-in mountings, for 115v and 230v, 50 to 60 cycle operation. **Autotron Inc.,** Box 722-RR, Danville, Ill.—*Circle 539.



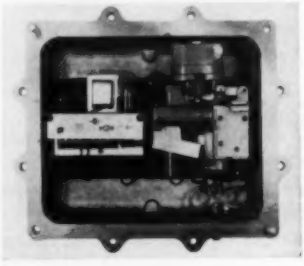
All-Air Circuit

Item 531—Safety for operators of presses, brakes, shears and other machines is provided by all-air circuit. The unit requires a two-handed operation to cause a machine cycle. Only one stroke occurs regardless of how long the palm button valves are held down. The buttons must be released to clear the circuit and again depressed to allow another stroke.

Circuit features a non-tie-down special purpose valve, a single stroke valve and a three-way poppet palm button valve arrangement. Components can be added to the non-tie-down and single stroke circuit to provide the following functions: Emergency stop—used to stop the press at any point of its stroke; continuous—used when press is put on automatic cycling and material is fed through the press continuously; top stop—permitting stopping of the press run at the top dead center position after the press has been running on continuous cycle. **Ross Operating Valve Co.,** 134 E. Golden Gate Ave., Detroit 3, Mich.—*Circle 531.

Direct Mounted Motor

Item 528—Designed with facilities for direct mounting of driven equipment, motor features accurate alignment which is provided by means of a totally-enclosed bracket. Shock resistant, cast-iron frame is heavily ribbed for strength and rapid heat dissipation. A guarded fan propels air over the ribs of the frame which ensures maximum cooling as well as self-cleaning characteristics. A brass slinger prevents moisture from entering at the take-off shaft. Castings are normalized to prevent misalignment of bearings. Lubriflush lubrication ensures complete purging of all old grease during relubrication without disassembly of the motor or removal of the fan guard. **U. S. Electrical Motors Inc.,** Box 2058, Terminal Annex, Los Angeles 54, Calif.—*Circle 528.



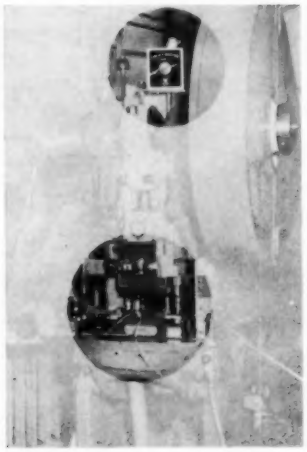
Level Controller

Item 513—Used to control the level of liquids including water, acids, alkalis, oils and aqueous solutions, pneumatic - electronic level

*For Inquiry Card, see page 17

controller can also be used with granular solids. Probes for the Pneutronic controller are of rigid rod-shaped structure, having no moving parts.

The systems are available with either of two types of pneumatic action: Model 111 produces an increase in air output with an increase in measured level. Model 112 produces a decrease in air output with an increase in measured level. **Fielden Instrument Div., Robertshaw-Fulton Controls Co.**, 2920 N. Fourth St., Philadelphia 33, Pa.—*Circle 513.



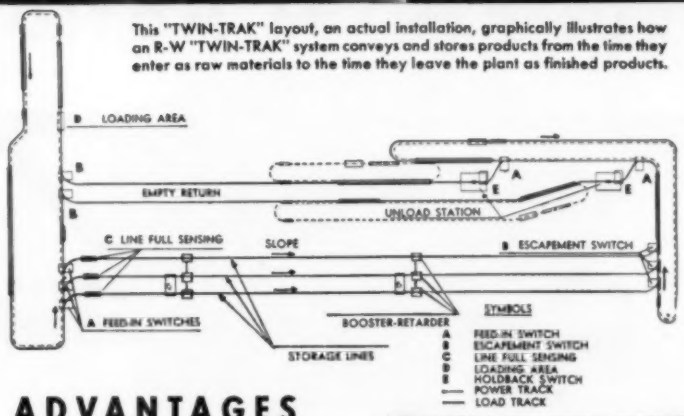
Press Control

Item 534—Developed to prevent tool and die damage caused by mechanical overload, electronic-mechanical press control is called the Circuit Master, Mark II. The unit was designed for use on automatic equipment such as presses and molding machines equipped with a solenoid or clutch-type release. The control is composed of a sensing assembly consisting of a compensating contactor mounted on the stationary part of the machine and a bumper mounted on the movable part. The contactor is connected by a single lead to a small and compact control unit containing a visual indicator and a switch, if desired.

The mechanism automatically senses the slightest mechanical overload from such malfunctions as faulty stock, tool dullness or misalignment, misfeeds, jams, non-

*For Inquiry Card, see page 17

This "TWIN-TRAK" layout, an actual installation, graphically illustrates how an R-W "TWIN-TRAK" system conveys and stores products from the time they enter as raw materials to the time they leave the plant as finished products.



ADVANTAGES

- **Provides trouble-free, automotive-selective control over product movement through entire plant.**
- **Economical and practical . . . provides added storage space . . . saves time, labor and money.**
- **Automatically supplies component parts to work stations from storage banks or lines.**
- **Economical to install . . . extremely flexible . . . quickly and economically revised or modified to meet your changing needs or future expansion plans.**
- **Ideal for conveying and dispatching products in multiple story buildings.**
- **Designed, manufactured and backed by the leading firm in this field for over 75 years.**

WRITE TODAY

for complete information . . . request Catalog F-192.

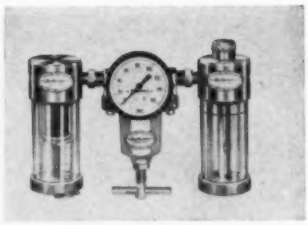
An R-W "TWIN-TRAK" System consists of one or more power tracks and as many storage or free tracks as desired. Available with efficient, economical manual or electronic selective controls designed to effectively meet your specific requirements.

Leading manufacturer of Track Hangers, all types of hardware and Electric Door Operators for over 75 years.

Richards-Wilcox
MANUFACTURING COMPANY
Materials Handling Division

417 W. THIRD STREET, AURORA, ILLINOIS • Branches in Principal Cities

ejection, freezing, etc. It stops any automatic machine on contact, precluding tool and die damage and replacement. **Wintriss Inc.**, 20 Vandam St., New York 13, N.Y. —*Circle 534.



Air Power Devices

Item 549—Used to filter and lubricate compressed air to insure efficiency and long life of pneumatic equipment, air line filters and lubricators are addition to line of controlled air power devices. The twin baffle plates of the Lubri-Air filter create centrifugal circulation of incoming air, forcing water and dirt particles to the base of the plastic reservoir. Any smaller dirt particles still in the air stream are then trapped by the Bendix Skinner 40 micron filter, leaving pure outgoing air.

The lubricator, by capillary action through a porous bronze wick and air pressure, provides an instantaneous response of properly lubricated air, even during intermittent use. Under a tamper-proof cap is housed the oil-mist control which gives full control over the wick area exposed to the air stream. Four port size models, ⅛, ¼, ⅜ and ½-inch are available. **Bellows Co.**, Akron 9, O.—*Circle 549.

GEM-17 DIAL INDEX TABLE

TRUE GENEVA MOTION

FOR FAST, *ACCURATE* AUTOMATION OF ASSEMBLY *and* MACHINING OPERATIONS

This new, high precision index table is accurate to plus or minus 0.001 in. on a 13 in. dia. work circle; can position work in as little as ½ sec.; indexes a 1,000 lb. fixture load.

BASIC SPECIFICATIONS: Standard Number of Stations—6, 8 or 12; 3 and 4 skip. Motor—Rotary air, fluid, or electric. Dial Plate—17 in. dia. standard; larger plates available. Rotation—Either direction. Interlock—Limit switch operated directly off locking bolt. Weight—200 lbs.

Gray engineers will help you adapt GEM-17 to your use. For recommendations, send specifications of your application. Illustrated brochure GE-21 and prices on request.

GRAY EQUIPMENT COMPANY

13600 Ford Road • Dearborn, Michigan • Telephone: TIffany 6-7573

Voltage Converter

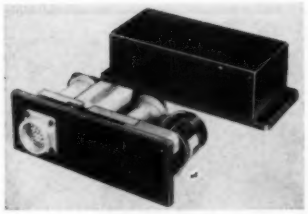
Item 504—Rotating electrical machine which changes both phase and voltage can convert single-phase, 115v, 60-cycle ac to three-phase, 230v, 60-cycle current. Machine is rated at 500w.

Relay starting switch, starting capacitor, and input and output receptacles can be mounted in a small box on the converter, at a separate station, within a converter frame or within a housing that eliminates operating noise. Intake and exhaust air vents are located in bottom halves of endbells, making the unit drip proof. **Kato Engineering Co.**, 1415 First Ave., Mankato, Minn.—*Circle 504.

Programing Device

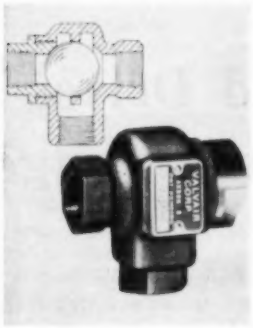
Item 511—Up to 13 channels are provided for any type of electrical programing of either a repeat cycling or random nature by MPR-13 multichannel programmer. The unit has an accuracy of one part in ap-

*For Inquiry Card, see page 17



proximately 50 thousand, and features rugged design.

The operating principle provides for an insulating tape similar to 35 mm photographic film to be advanced at a precise rate of speed between 13 contactors. The tape is marked lengthwise in time and divided in 13 channels. Up to 13 types of signals may be generated by the device for the accurate control of a group of electrically operated equipment. This is accomplished by punching holes in the control tape to allow the contactors to close a period of time equal to the hole or slot length. **Photographic Products Inc.**, 1000 N. Olive St., Anaheim, Calif.—*Circle 511.



Directional Valve

Item 523—Affording instant switch-over from automatic to manual control, directional valve is installed as a tee in the inlet lines. It can be used to prevent intermixing of supply when two gases or liquids are being delivered alternately to a tank or container.

Suitable for use with air, oil, water or media compatible with both Hycar and bronze, the valve comes with ¼ and ⅜-inch NPT ports. Net open area between seat and ball is equal to transverse area of ⅜ standard pipe. **Valvair Corp.**, 454 Morgan Ave., Akron 11, O.—*Circle 523.

*For Inquiry Card, see page 17

THAYER SCALE aids safe packaging of powdered chemicals

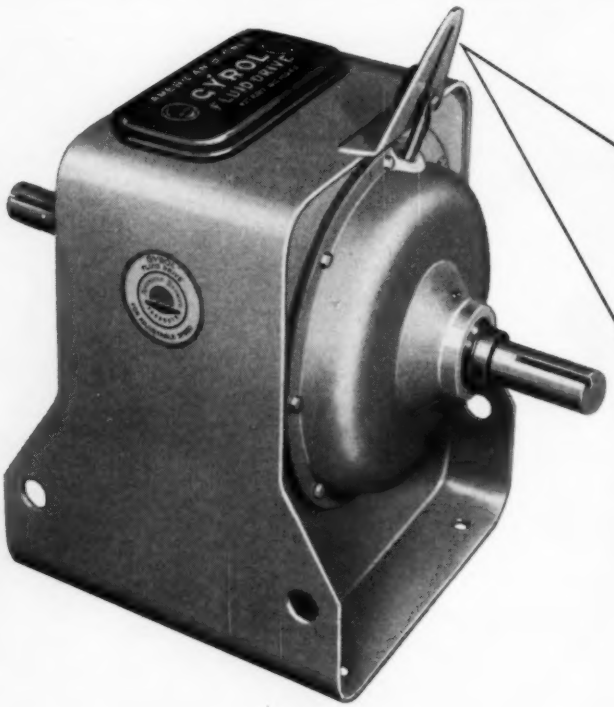
Personnel are protected by using this fully automatic Thayer Scale in packaging powdered chemicals. A warehouseman safely stockpiles empty drums on a conveyor belt where they are *automatically* spaced, filled to a precise net weight, then conveyed away for covering. Dependability is assured by the THAYER PLATE leverage system which has no knife-edge pivots and is guaranteed accurate for the life of the scale. For information on models handling products which flood, stick or are lumpy please write THAYER SCALE CORP., 5 THAYER PARK, PEMBROKE, MASS.

THE Thayer SCALE

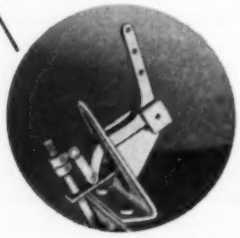
AUTOWEIGHTION

BATCHING • FILLING • CHECKWEIGHING • AUTOMATICALLY

Circle 693 on Inquiry Card



Micro-scoop speed control for manual operation



Lever speed control for automatic controller operation

American Blower *Gýrol*® Fluid Drives now available in lower horsepower ranges!

Type VS, Class 2 Gýrol Fluid Drives for 1- to 25-hp applications. Also available with flange-mounted motor, as shown.

Adaptable to either automatic or manual control, American Blower Type VS, Class 2 Gýrol Fluid Drives come in a complete range of new smaller sizes—1 hp to 25 hp, speeds to 3600 rpm—to satisfy your every power-transmission need!

These compact, self-contained units offer an answer to many industrial-drive problems because of their important benefits: adjustable, stepless speed control; full reversibility; 5 to 1 speed range; no-load starting; protection against shock; quiet operation.

For full information on the complete line of Type VS, Class 2 Gýrol Fluid Drives, 1-800 hp—or other designs to 12,000 hp—contact our nearest branch office. Or write: American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

AMERICAN BLOWER

Division of AMERICAN-Standard

Circle 694 on Inquiry Card

catalogs and literature

Latest automation information. For copies use card page 17.

633. Cycling Drive Units

Cycledynamics Inc., 19025 *W. Davison, Detroit* 23, *Mich.*—12-*page bulletin*—Providing start-stop and repetitive cycle control for all types of mechanical drive systems, combined clutch, brake and torque-limiting unit is discussed and illustrated in bulletin. Information on basic arrangements, mounting data and ordering chart are included.—*Circle 633.

584. Hopper Feeders

Rehnberg-Jacobson Mfg. Co., 2135 *Kishwaukee St., Rockford, Ill.*—4-*page pamphlet*—Used in automation applications, hopper feeders are the subject of pamphlet. Photographs of three applications and chart giving adjustable hopper speeds are included.—*Circle 584.

638. Hose and Hose Ends

Fort Wayne Div., Weatherhead Co., Fort Wayne, Indiana—40-*page catalog*—Information on bulk industrial hose, permanently attached hose assemblies, swaged hose assemblies and ends, hose swivel adapters, and assembly instructions are included in illustrated catalog. Charts for hose selection to carry particular agents are featured.—*Circle 638.

618. Short Case Sealer

J. L. Ferguson Co., Joliet, Ill.—4-*page pamphlet*—Developed to apply glue spots and seals all types of paper cases, Packomatic machine is the subject of illustrated pamphlet. Operating characteristics, photographs and diagrams of the automatic machine are included.—*Circle 618.

602. Overhead Conveyors

Chainveyor Corp., 5618 *E. Washington Blvd., Los Angeles* 22, *Calif.*—10-*page bulletin*—Information on lightweight and flexible conveyors which handle any type of intermediate loads through stage processing, intermittent storage, or stop and go operations is included in planning folder. Planning grids and an explanatory diagram of a company system are provided in the folder.—*Circle 602.

599. Stamping Presses

Alpha Press & Machine Inc., 9281 *Freeland Ave., Detroit* 28, *Mich.*—12-*page bulletin*—Available in capacities from 75 to 200 tons, automatic two-point, back gear, underdrive production presses complete with ingoing and pullout roll feeds are described in Catalog No. 57-2. Specifications and diagrams of four models are included; photographs illustrate features of the presses.—*Circle 599.

596. Air/Oil Cylinders

Logansport Machine Co. Inc., Logansport, Ind.—16-*page booklet*—Designed for air or oil service, line of cylinders which are available in 14 different mounting styles is the subject of Catalog 100, Section 5. Specifications and diagrams of models in the line are included; accessories are also covered.—*Circle 596.

608. Panel Wiring

Stahlin Brothers Inc., 232 *Maple St., Belding, Mich.*—8-*page bulletin*—Raceway techniques for wiring of electrical and electronic equipment are included in Bulletin S-301. Use of raceways and precut wires for simplifying wiring; procedure for installation; and descriptions of available raceways are provided.—*Circle 608.

589. Conveyor Tubing

Jessall Plastics Inc., Kensington, Conn.—2-*page pamphlet*—Adaptable to pneumatic, mechanical or gravity methods of conveyance, conveyor tubing called Plasticarrier is described in pamphlet. Basic dimensions, application and shaping data are included.—*Circle 589.

597. Contact Meter-Relays

Assembly Products Inc., Wilson Mills Rd., Chesterland 1, *O.*—40-*page catalog*—Used to both indicate and control most physical and chemical conditions that can be detected electrically, contact meter-relays are described in Catalog No. 4-C. Ordering information for meter-relays to be used in original equipment or self-contained control packages is included; circuits for providing different types of control action are discussed.—*Circle 597.

598. Shielded Electrification

American Monorail Co., 13107 *Athens Ave., Cleveland* 7, *O.*—8-*page bulletin*—Polyvinyl chloride shielded electrification called Kant-Shock, for overhead handling systems is the subject of Bulletin KS-1. Insulating sections, collectors, switches, interlocks, track curves, and bracket assemblies are also illustrated and discussed.—*Circle 598.

592. Rotary Joints

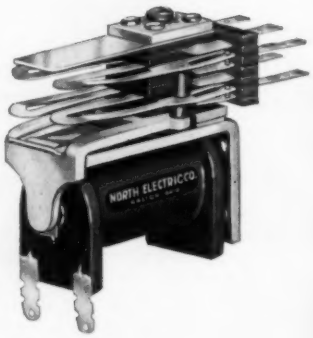
Barco Mfg. Co., 500-530 *N. Hough St., Barrington, Ill.*—4-*page pamphlet*—Featuring carbon bushings and seals which require no lubrication or other maintenance, line of Type C rotary joints for steam, water, oil, air or gas is described in Catalog No. 310. Cutaway photographs and specification charts are included.—*Circle 592.

605. Electric Pushbuttons

Furnas Electric Co., 1128 *W. McKee St., Batavia, Ill.*—32-*page catalog*—Used for remote pilot control of magnetic controllers and similar devices, pushbuttons, selector switches and pilot lights are discussed in Catalog 5606A. Description of components and complete units, dimensions, cam action and schematic diagrams are given.—*Circle 605.

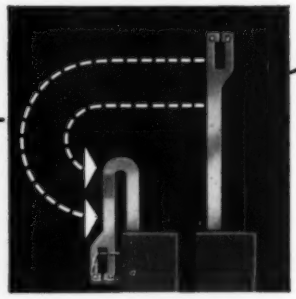
*For Inquiry Card, see page 17

telephone | *quality in a miniature relay?*



yes!

IN NORTH "M" TYPE RELAY!



Note the "U" shape of the lever springs. From the pile-up, the lever spring extends the full length of the coil, then doubles back an equal distance to the fixed contact points.

Stability of operating characteristics, with which relay dependability is achieved, can be maximized by a configuration which puts the fixed contact springs as close as possible to the clamping axis of the pile-up and yet escapes the penalty of the greatly foreshortened lever spring common in miniaturized relays.

In the North "M" Relay, both requirements have been met.

The fixed contact springs are lateral extensions from the anchoring pile-up, minimizing any possibility of post-adjustment variation.

The unique "U" design of the lever springs in North's "M" Relay enables it to meet critical space requirements while retaining lever spring length to achieve telephone dependability.

The armature in North's "M" type relay operates on a knife hinge—never needs lubrication, and the small amount of armature travel provides fast operation.

Lightweight operating parts keep contact bounce at an absolute minimum.

North's "M" type relay can be furnished with 6, 12, 24, 48, or 100 Volt coils; 1, 2, or 4 DPDT standard spring arrangements; with double gold or single silver contacts; with dust cover and octal mounting plug.

North's "M" type relay is available from stock.

Length 1-13/16", Height 1-1/4", Width 25/32", Weight 1.8 oz.

INDUSTRIAL DIVISION

NORTH ELECTRIC COMPANY

727 SOUTH MARKET STREET • GALION, OHIO

Available in Canada through Ericsson Telephone Sales of Canada, Ltd., Montreal 8, P. Q.

Circle 695 on Inquiry Card

585. Power Units

Hydraulic Power Equipment Co., 210 Columbiana Rd., Box 431, N. Lima, O.—*12-page bulletin*—Line of hydraulic power pacages in small, medium and heavy duty types is described and pictured in Catalog No. 9-56. Diagrams and specifications of each model are included.—*Circle 585.

609. Ball Bearings

Split Ballbearing Corp., Lebanon, N.H. — *28-page catalog* — Fractured race technique of bearing design and manufacture is discussed in Catalog No. 57. Also described and illustrated is a complete line of split ball bearings, roller bearings and pillow blocks.—*Circle 609.

649. Air Control Valves

Ross Operating Valve Co., 120 E. Golden Gate Ave., Detroit 3, Mich.—*71-page catalog*—Five pilot heads which are interchangeable with seven valve bodies make up Starline series of air control valves described in illustrated catalog. Dimensional data, parts and price lists, and flow diagrams are included.—*Circle 649.

635. Motor-Generator Sets

Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa.—*8-page bulletin*—Motor generator sets and accessories developed for induction heating are described and illustrated in Bulletin DC 28-750. Specifications are presented with photographs of various models included.—*Circle 635.

588. Industrial Filters

Industrial Filtration Co., Dept. GB-471, Lebanon, Ind.—*8-page bulletin*—Disposable media gravity, combination gravity and magnetic, vacuum, pressure and screen-type settling filters are illustrated and described in bulletin. Data on the application and operation of each type are included; photographs illustrate the text.—*Circle 588.

610. Winding Device

Hobbs Mfg. Co., 18 Salisbury St., Worcester 5, Mass.—*4-page pamphlet* —Featuring constant tension from start to finish in the winding of roll-fed material, Alquist winder is discussed and illustrated in pamphlet. Application photographs and dimensional sketch are included.—*Circle 610.

*For Inquiry Card, see page 17

594. Automatic Molding Press

Baker Bros. Inc., P.O. Box 101, *Toledo* 10, *O.—8-page bulletin*—Line of automatic presses ranging from 60 to 450-ton capacity is the subject of illustrated bulletin. Photographs show features of the presses; specifications are given in chart form.—*Circle 594.

603. Motors and Drives

Reliance Electric & Engineering Co., 24701 *Euclid Ave., Cleveland* 17, *O.—8-page bulletin*—Complete line of ac and dc motors, gearmotors, motor-generator sets, motor controls and packaged mechanical and electronic adjustable speed drives are described and illustrated in Bulletin A-2501. Photographs and brief descriptions of numerous models are included.—*Circle 603.

587. Long-Life Capacitors

Industrial Condenser Corp., 3243 *N. California Ave., Chicago* 18, *Ill.—12-page bulletin*—Used in instrumentation, communication networks, computers, meter damping, transistor circuitry, etc, line of capacitors is the subject of Catalog 1165. Charts, photographs and graphs illustrate the bulletin.—*Circle 587.

593. Metalworking Machines

Cincinnati Milling Machine Co., Cincinnati Grinders Inc., Cincinnati 9, *O. —72-page catalog*—Line of milling, grinding, broaching, metal forming and selective hardening machines which feature self-adjusting spindle bearings, automatic grinding wheel balancing, automatic air-electric gage sizing, and 180 and 360-degree automatic profile milling is described in Catalog No. M-1961. Grinders which include automatic cycles with independent adjustment of each event are illustrated. Also discussed are automated transfer machine, aircraft skin miller, automatic electrical discharge machining unit, and several other automatic machine tools for special applications.—*Circle 593.

641. Industrial Belting

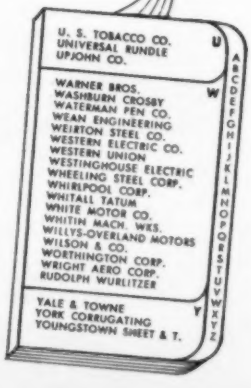
Voss Belting & Specialty Co., 5645 *N. Ravenswood Ave., Chicago* 26, *Ill. —8-page bulletin*—Used for conveying applications ranging from general industrial to sanitary service, line of industrial belting is described and illustrated in bulletin. Specification charts and working formulas are included.—*Circle 641.

*For Inquiry Card, see page 17

Floor-mounted Belt and overhead Live Roller lines are connected by Vertical Reciprocating Conveyor. Materials handling is fully automatic with this Logan system. Production and packing are linked to adjoining warehouse and shipping department.

The LEADERS use Logan

The mark of a leader is—"ability to deliver the goods." In more ways than one, Logan Conveyors aid the nation's leading industries to do just that. Logan equipment makes important intra-plant deliveries, linking up all production operations into one efficient whole. And these conveyors, built to convenient working heights, save bending, lifting and straining, too. Remember you get value-plus, that something-added when you specify Logan-engineered conveying equipment. Write today to—



LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KENTUCKY

Logan Conveyors

Circle 696 on Inquiry Card

with the **LIPE Automatic MAGAZINE LOADING BAR FEED"**

says Screw Machine Foreman Willis J. Forbes*

Up to six months ago, the record per-machine production in our department for a single day was 5760 pieces. Our best monthly average was 5300 pieces per day. We tried out a Lipe A.M.L. to feed one machine, turning at the same cutting speed as before. In the first full day of operation, the A.M.L.-fed machine matched our top monthly average by 1:25 P.M. . . . and ended the day at 4:00 P.M. with a production of 7823 pieces! It has continued to turn out that number daily, *for six months!*

Why? The Lipe A.M.L. feeds stock continuously: No repeat motion for feed-outs. No down-time for changing feed fingers, or for remnant disposal. No cutting air — and when you stop cutting air, you start cutting costs. That's why we are now equipping our department throughout with Lipe A.M.L. Bar Feeds.

WRITE OR WIRE for a FREE Lipe Sales Engineering estimate of production increases, savings and amortization time of Lipe A.M.L. Bar Feeds in your production layout.

*Photographer's models and pseudonyms used to protect company identity and confidential information.

Lipe-ROLLWAY CORPORATION SYRACUSE 1, N.Y.

MACHINE TOOLS • HEAVY-DUTY AUTOMOTIVE CLUTCHES • PORTABLE POWER HACK SAWS

Circle 697 on Inquiry Card

575. Can Making Units

E. W. Bliss Co., Canton 10, *O.*—12-*page bulletin*—Gang slitters, automatic duplex trimmer and slitter and a scroll shear for medium and high speed can making lines are described in Section 1-Catalog 36-B. Also illustrated and discussed are a body blank stacker, motor driven grinding attachment and slitter accessories.—*Circle 575.

621. Monorail Dispatcher

Louden Machinery Co., Fairfield, Iowa—24-*page catalog*—Selectomatic control for automatic materials handling is described and illustrated in catalog. The system consists of an automatic motorized overhead tractor with the Selectomatic control; a carrier which may consist of a bucket or a hoist, etc.; and the track system. Principles of operation are discussed; photographs illustrate uses of the system in handling bulk materials, bagged materials and discrete parts.—*Circle 621.

604. Electrical Controls

W. F. & John Barnes Co., Electrical Controls Div., 301 *S. Water St., Rockford, Ill.*—8-*page bulletin*—Group of application photographs illustrates diversity of electrical controls and systems designed by company. Bulletin includes pictures of controls for machine tools, plating line, flour processing, plastic molding process, paper making machinery, heat treating furnaces, packaging application, coal washing and water treatment.—*Circle 604.

645. Multiple Drive System

U. S. Electrical Motors Inc., Box 2058, *Terminal Annex, Los Angeles* 54, *Calif.*—4-*page pamphlet*—Simultaneous speed changes of interlocked units are provided by Varidyne multiple drive system described and illustrated in pamphlet. Sketches and photographs illustrate typical applications of the drive system.—*Circle 645.

617. Gear Chucks

Garrison Machine Works Inc., Dayton 4, *O.*—4-*page pamphlet*—Brief discussion on ten types of losses due to inadequate gear chucks is included in illustrated pamphlet. Photographs illustrate company facilities utilized for the solution of customer gear chucking problems.—*Circle 617.

*For Inquiry Card, see page 17

576. Closed Circuit TV Camera

Blonder-Tongue Laboratories Inc., 526-536 North Ave., Westfield, N. Y. —8-page bulletin—Consisting of a camera, control generator, plug-in channel modulator and multiconductor interconnecting cable, Model TVC-1-A closed circuit TV camera equipment is discussed in bulletin. Specifications, installation instructions, and data on lens field coverage are included.—*Circle 576.

579. Worm Gear Drives

Cleveland Worm & Gear Co., 3249 E. 80th St., Cleveland 4, O.—16-page booklet—Developed to provide dependable speed reduction, line of speed reducers, worm gear sets and special units is discussed in Bulletin No. 145. Photographs and descriptions of horizontal right angle reducers, vertical reducers and multiple reduction units are included.—*Circle 579.

625. Process Instrumentation

Leeds & Northrup Co., 4907 Stenton Ave., Philadelphia 44, Pa.—12-page bulletin — Primary elements for detecting changes in temperature, pH, gas concentrations and other operating variables in chemical process applications are described in bulletin. Speedomax loggers, scanners, recorders, process gas analyzers, and complete process control systems are also covered. Photographs and brief descriptions of each instrument are included.—*Circle 625.

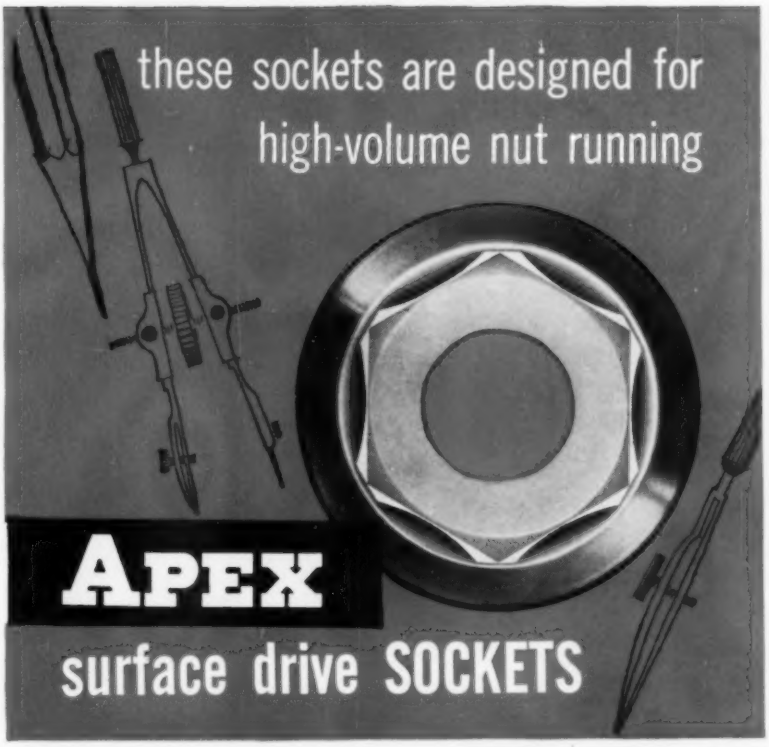
623. Assembly Machines

Roller Gear Div., Ferguson Machine Corp., P.O. Box 5841, St. Louis 21, Mo.—6-page pamphlet—Expanded line of standard Trans - O - Mator straight line transfer machines for automatic assembly is discussed in Bulletin No. 401. Typical applications and design features are illustrated; specifications for units with 6, 8, 12, 16 and 24-inch strokes are given.—*Circle 623.

647. Package Controls

Tipp-Tronic Inc., Tipp City, O.—16-page booklet—Suitable for applications where a chemical or mechanical function can be measured electrically, automatic meter relay controls are described in Catalog AC-2. Photographs and specifications of various models of the self-contained controls are included.—*Circle 647.

*For Inquiry Card, see page 17



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3/8"	Short Standard (thin or standard wall) Long Extra Long	3/8" through 7/8" 3/8" through 1-1/16"
1/2"	Standard (thin or standard wall) Long Extra Long (thin or standard wall)	3/8" through 1-1/16"
5/8"	Standard Extra Long (thin or standard wall)	7/16" through 1-1/16"
3/4"	Standard Extra Long (thin or standard wall)	1/2" through 1-1/16"

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648. Precision Finishing

Roto-Finish Co., 3700 *Milham Rd., P.O. Box* 988, *Kalamazoo, Mich.*—24-*page catalog*—Machines which perform grinding, deburring, descaling, polishing, and coloring operations are discussed and illustrated in catalog. Photographs and descriptions of special automatic machines for finishing are included; flow diagrams and information on accessories are also given.—*Circle 648.

581. Automatic Writer

Commercial Controls Corp., One Leighton Ave., Rochester 2, *N. Y.*—24-*page catalog*—Cartoon-type illustrations are used to show how common language punched paper tape is created by automatic writing machine for integrating other business equipment, or to actuate automatic writers to produce documents. Various applications for the Flexowriter machine are described.—*Circle 581.

611. Control Devices

General Purpose Control Dept., General Electric Co., Bloomington, Ill. — 12-*page bulletin* — Magnetic starters, oil-tight pushbuttons, relays, solenoids, pneumatic time delay relays, limit switches, plugging switches and panels are included in line of control equipment described in bulletin. All of the controls are designed to meet JIC specifications. Photographs of various models and a brief description of each control device are included.—*Circle 611.

636. Magnetic Drives

Whitney Chain Co., 237 *Hamilton St., Hartford* 2, *Conn.*—6-*page pamphlet*—Data on design, drive features, operating and performance curves, output torque rating-dimensions, and selection chart for magnetic drives are included in Bulletin W-T 1-57. Photograph of installations and applications are covered in this pamphlet.—*Circle 636.

571. Automatic Packaging

Bartelt Engineering Co., 1900 *Harrison Ave., Rockford, Ill.*—4-*page pamphlet*—Line of packaging machinery which forms a pouch-package and fills, seals, and cartons it automatically is illustrated and described in pamphlet. Line accommodates a variety of carton styles and sizes.—*Circle 571.

*For Inquiry Card, see page 17

568. Press Room Equipment

Special Engineering Service Inc., 8161 *Livernois, Detroit* 4, *Mich.*—12-*page bulletin*—Hydraulic punch press feeds, combination cradle and straighteners and other press room equipment for feeding coil stock are described and shown in catalog. Equipment illustrations in bulletin are accompanied by data on capacity, application and characteristics.—*Circle 568.

619. Clutches & Accessories

Marland One-Way Clutch Co., 561 *W. Hillgrove Ave., La Grange, Ill.*—76-*page catalog* — Automatic freewheeling clutches, combination clutch-couplings, backstops and enclosed clutch units are included in line of components described in catalog. Numerous illustrations and information on application methods, selection procedures, tables, dimensions and weights are included.—*Circle 619.

586. Gears & Speed Reducers

Horsburgh & Scott Co., 5114 *Hamilton Ave., Cleveland* 14, *O.*—116-*page handbook*—Spur, internal, herringbone, helical, spiral, straight bevel, and numerous other types of gears are described in comprehensive Catalog 57. Specifications and operating characteristics are given in chart form; photographs of gears and speed reducers are also included.—*Circle 586.

607. Flat Annular Diaphragms

Statham Laboratories Inc., 12401 *W. Olympic Blvd., Los Angeles* 64, *Calif.*—4-*page pamphlet*—Used in electroacoustics and instrument technology, flat diaphragms are discussed in "Instrument Notes," No. 31. Equations defining the characteristics of the rigid annulus form of flat diaphragms are given.—*Circle 607.

615. Horizontal Indexing

Hartford Special Machinery Co., Hartford 12, *Conn.*—2-*page pamphlet* —Line of components which are engineered for assembly into high production flexible automatic machines is described in pamphlet. Horizontal and vertical automatic drilling and tapping units, adapters, tunnel columns, straight columns, index table supports and table tops for use in 65-inch indexing machines are illustrated.—*Circle 615.

*For Inquiry Card, see page 17

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A push button order filling system in which an operator at a control console directs the flow of material from 66 storage lines. Photo courtesy of Gallo Sales Co.

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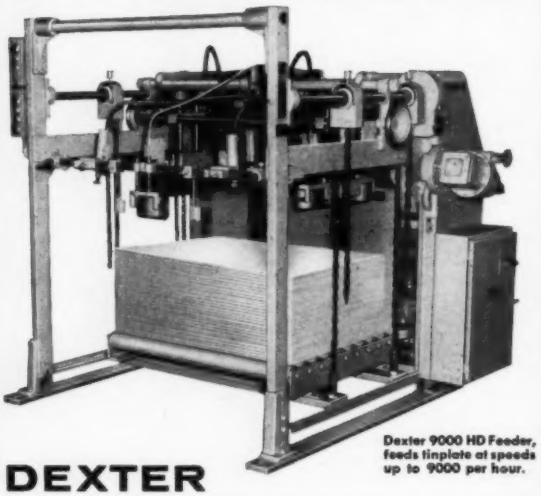

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595. Computing Relay

Bailey Meter Co., 1050 *Ivanhoe Rd., Cleveland* 10, *O.*—*4-page pamphlet*—Features, application and operating characteristics of computing relay for pneumatic control systems are given in pamphlet P99-3. Curves of proportional, reset and rate control actions are given; equations of some computing actions are also included.—*Circle 595.

573. Ultrasonic Cleaning

Pioneer-Central Div., Bendix Aviation Corp., Davenport, Iowa—*8-page bulletin*—Capable of cleaning small assemblies and parts as well as performing full-size industrial cleaning jobs, line of ultrasonic cleaning equipment is discussed in bulletin. Illustrations of parts handled by the system and quotations from users are included.—*Circle 573.

606. Electric Power Drives

Sterling Electric Motors Inc., 5401 *Telegraph Rd., Los Angeles* 22, *Calif.*—*20-page booklet* — Normal speed electric motors, geared motors, variable speed transmissions and speed reducers are included in line described in condensed catalog. Photographs of various models and selection tables which include specifications and prices are covered—*Circle 606.

616. Thermistors

Thermistor Div., Gulton Industries Inc., 212 *Durham Ave., Metuchen, N.J.*—*10-page bulletin*—Used for temperature measurement, control and compensation, time delay, liquid level detection, flow, and power measurement, etc., Glennite thermistors are described in Bulletin T-100. Applications and circuitry for wafer, rod and bead thermistors are included, along with tables showing the characteristics of different types.—*Circle 616.

570. Honing Equipment

Barnes Drill Co., Rockford, Ill.—*44-page catalog*—Line of equipment designed to give automatically controlled size, finish and accuracy is described and illustrated in Catalog No. 550. Tables and charts for proper speed selection, instructions on calculating work stroke, and requirements for various honing applications are included; photographs of numerous machines illustrate the catalog.—*Circle 570.

*For Inquiry Card, see page 17

640. Redraw Presses

Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.—*12-page bulletin*—Designed for production of straight and shouldered deep shells, line of horizontal, multistation automatic redraw presses is the subject of Circular No. 926-M-4. Descriptions of several applications and illustrations of progressive workpiece forms are given; photographs of the presses and data on attachments are also included.—*Circle 640.

613. Coil Cars

Herr Equipment Corp., 1200 *Vine St. N.E., Warren, O.*—*6-page pamphlet*—Method of loading coils onto payoff reels and unloading coiling reels is provided by heavy-duty coil cars which are described in Bulletin 562. Capacities and dimensions of three standard units are listed in chart form; photographs are also included.—*Circle 613.

572. Gas Chromatograph

Process Instruments Div., Beckman Instruments Inc., Fullerton, Calif.—*4-page pamphlet*—Designed for automatic analysis of process streams, Model 220 industrial gas chromatograph is the subject of illustrated pamphlet. Specifications for the units and a diagram of process sampling arrangement are included.—*Circle 572.

626. Magnetic Clutch & Brake

Fawick Airflex Div., Fawick Corp., 9919 *Clinton Rd., Cleveland* 11, *O.*—*6-page pamphlet*—Featuring complete control of rotary acceleration or deceleration with remote control through pushbuttons, relays or limit switches, magnetic clutches and brakes are described and illustrated in Bulletin M-101. Dimensional drawings and specifications on two brake models and one clutch model are included.—*Circle 626.

574. Automatic Cartoning

Bivans Corp., 2431 *Dallas St., Los Angeles, Calif.*—*4-page pamphlet*—Designed to provide an automatic packaging system, line of cartoning machines is the subject of illustrated pamphlet. Units which set up tuck-end cartons and are conveyor loaded, carton closer and coder-printer are discussed; specifications and operating information are given.—*Circle 574.

*For Inquiry Card, see page 17

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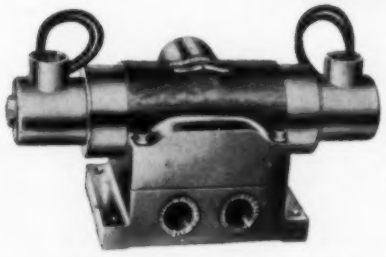

MV SERIES double solenoid for 3 or 4-way operation in ¾" and 1" port sizes is only 13¾" long. Shown with removable sub-base; also available in threaded body, and with single solenoid.

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Los Angeles, Calif.

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Fig. 1 — TRAK-RAK fork lift at top of column, lifting bundle of steel rod. Unit serves 3 long aisles of racks.

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A 5 ton capacity toprunning TRAK-RAK Crane was installed in each of two 40 ft. wide bays to serve specially designed 18 ft. high material storage racks (Fig. 1) Each crane bridge has an overhead trolley, from which is suspended an electrically operated rotating column

Fig. 2 — Carriage equipped with 2 pairs of forks. Operator is flopping outer forks up.

equipped with a special fork lift. All operations of the fork lift, which revolves to serve either side of the aisles, moves toward or away from the racks, and raises or lowers on the column, are controlled by the operator who rides with the carriage.

Two pairs of forks are mounted on the carriage. The outer forks may be flopped back (Fig. 2) leaving the inside forks in position for handling palletized or crated material. For handling long boxes, bars, etc., the outside forks are flipped back into working position.

A TRAK-RAK feature which added to handling speed and insured safe operation was the safety interlock switch system which prevents the column from running

Fig. 3 — TRAK-RAK column requires minimum aisle space for operation.

into a rack and permits full rotation only when the unit is safely beyond the end of the racks.

The A. C. Leslie Company reports that a similar TRAK-RAK System installed in its Montreal warehouse permitted a 37% savings in capital building investment with equally good operating efficiency and economy.

For complete details on the TRAK-RAK System of vertical storage and handling, write the manufacturer:

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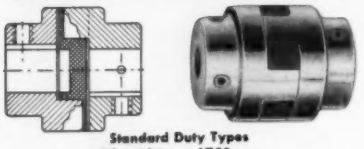
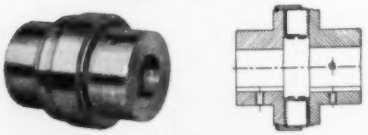
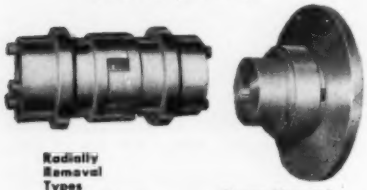


Standard Duty Types
.05 to 40 hp. at 1750 rpm.



Medium and Heavy Duty Types
2.6 to 810 hp. at 100 rpm.



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AUTOMATION

problem forum

Readers with problems concerning systems, equipment or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Solution suggestions should refer to case number and title of the problem involved.

Since the inception of AUTOMATION magazine, many readers have outlined problems to the editors and inquired about sources for information and hardware to solve their problems. Knowing that some of the best production innovations contributing to success have been adapted from the experiences of others, often in widely diverse industries, the editors have been actively applying this cross-fertilization process as one of the important approaches to effective and economical automation. In the exchange of such information there is opportunity to stimulate additional interchange of useful data. To provide this extra editorial service this issue continues a regular department devoted to questions and suggestions concerning systems, equipment and components for automated operations.

Readers having specific questions or problems are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. To develop practical solutions, problems will be published identified only by a case number and descriptive title. Suitable suggestions will be welcomed and should refer to case number and title of the problem involved. Suggestions and solutions to problems will be transmitted promptly and pertinent excerpts will be published in succeeding issues.

Some questions for which answers are presently sought are included in this column. We hope that AUTOMATION readers having suggestions or equipment to suit the needs, or having questions of their own, will participate freely in this forum and assist in the general advancement of the technology.

Case No. 1254-P
Hopper Level Control

. . . We are trying to locate the names of companies who manufacture a unit which will control the volume of powdered clay in a hopper.

We are planning on feeding the clay into the hopper by means of a screw conveyor. When the clay reaches a specified level, the control will then stop the screw conveyor.

We would appreciate receiving the names of companies who produce such equipment . . .

Production Manager

♦ ♦ ♦

Case No. 1064-P
Detecting Metal in Hay

. . . We are looking for a metal detecting device that would be practical for our operation. This device would be used for detecting metal in baled hay being pushed at one end by slats that are attached at each end to a drag chain. After the bales are in this conveyor, the wires are removed. The cross-section of a bale of hay as far as the width and depth measurements are concerned is about 16 by 19 inches.

The desired operation would be to have a device that would detect metal, if any, in the bale and then through some system stop the movement of the conveyor . . .

Manager

♦ ♦ ♦

Case No. 1256-P
Lathe Loading and Unloading

. . . We are interested in automation as related to machining of metal parts. More specifically we are interested in automatic transfer equipment that would automatically load and unload parts from engine lathes.

Small Machine Shop

♦ ♦ ♦

Suggestions For 1199-P
Tinning Brush Leads

. . . It is our suggestion that you recommend to this project engineer that he forget about an automated operation for the soldering of his braided leads, unless he can foresee tripling their production and sales requirements. At the present rate of production he could not write off the cost of the equipment in a reasonable period of time. It is TAB's opinion that there are many areas within that particular plant where

automation principles could be applied to much greater advantage than in this particular operation . . .

Howard Shambaugh
TAB Engineers

♦

. . . We are interested in discussing your reader's problem with him. The situation looks fairly straightforward but a lot depends on the size and condition of the braided lead. We shall look forward to hearing further in this matter . . .

E. W. Larrabee
E. W. Larrabee Inc.

♦

. . . We have had considerable experience on the automation of carbon brush assembly. Please give us your reader's name and address so that we can discuss this problem in specific detail . . .

F. F. White
Automation Development Corp.

♦ ♦ ♦

Suggestions For 1156-P Index Sheets and Tabs

. . . Your reporting of the case in which a manufacturer is in need of an automatic machine to produce plastic index strips was read with interest; perhaps you could forward this to the manufacturer and we could be of service to him.

We would like to visit with the above manufacturer at his convenience to discuss our qualifications and background in greater detail. We would then like to review the problem and make certain recommendations, including a proposal for the equipment . . .

A. Froman
The de Florez Co. Inc.

♦

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J. R. Humphrey
Humphrey Design Co.

♦

. . . Be advised that we are very interested in discussing this problem with the manufacturer. It may be interesting to note that we have solved a problem allied to this one.

Ray Tetrault
Barkley & Dexter Laboratories Inc.

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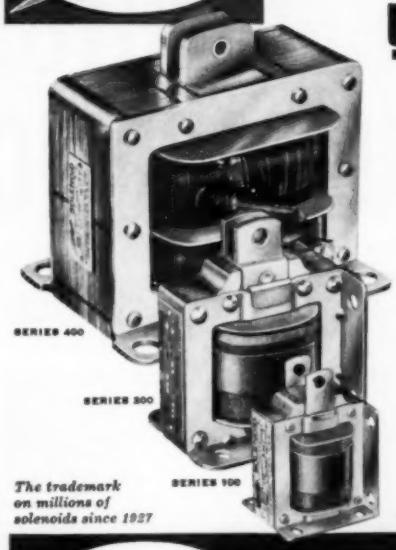

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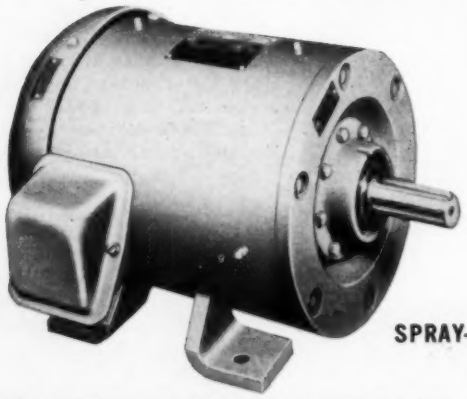

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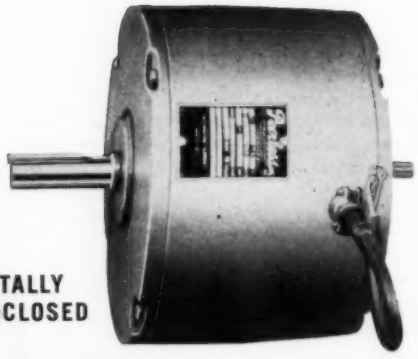

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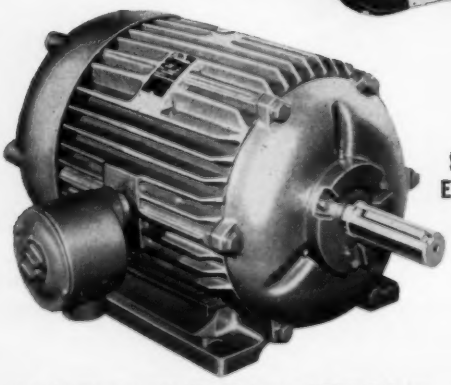

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RECTIFIER OR M-G SET?

By E. J. LAUGHLIN
Mgr., Metallic Rectifier Sales
Westinghouse Electric Corp.

REQUIREMENTS for direct current power continue to grow with industrial expansion. To keep pace, means for converting ac to dc are changing and improving. New silicon and germanium conversion equipment is now available in addition to the well-known selenium power conversion units. The increased use of rectifiers has by now made dc distribution systems practically obsolete. New ac distribution systems are designed to deliver power efficiently virtually everywhere; it is only logical to benefit from them by using on-the-spot power conversion units wherever dc is required. Generally, the static conversion equipment that best meets modern conditions is the semiconductor rectifier. It may be the selenium type, which has been in use for over 15 years, or the more recent type employing silicon or germanium units. For medium dc voltages any of these types may be used. Current opinion, however, is that silicon is to be preferred over germanium because of the high inverse voltage rating of the former and its ability to operate at higher ambient temperatures.

Selection Factors

In selecting a suitable dc power supply for machine tools, several important factors should be considered. Seven major points are: application; original cost; installation cost; maintenance expense; space and weight; quietness of operation; and efficiency and light load losses. Most applications of conversion equipment in the machine tool industry involve dc motors, magnetic chucks, solenoids, and dynamic braking. Of these, meeting power requirements for dc motors is doubtless the most pressing problem.

The type of speed control required often dictates the choice of power supply. If it is of the constant-torque, variable-voltage type, the m-g set is still predominantly used particularly for applications above three horsepower. But if the application requires constant horsepower, and speed control by adjustment of the dc motor shunt field, then a selenium or silicon rectifier is more likely the answer. The unit shown in *Fig.* 1 is typical of adjustable-speed, constant-horsepower applications; it is a 50-kw, 250-volt silicon power unit supplying power to a large boring mill. Where overhauling loads occur, such as in elevator equipment or for high inertia loads connected to a dc motor, dynamic braking control is available to work with the static rectifier to absorb the regenerated power. It cannot flow back through the rectifier.

In *Fig.* 2 are set forth comparative cost to the user of m-g sets and various types of semiconductor rectifiers. The comparison assumes an m-g set comprising an ac motor and dc generator on a bedplate, with

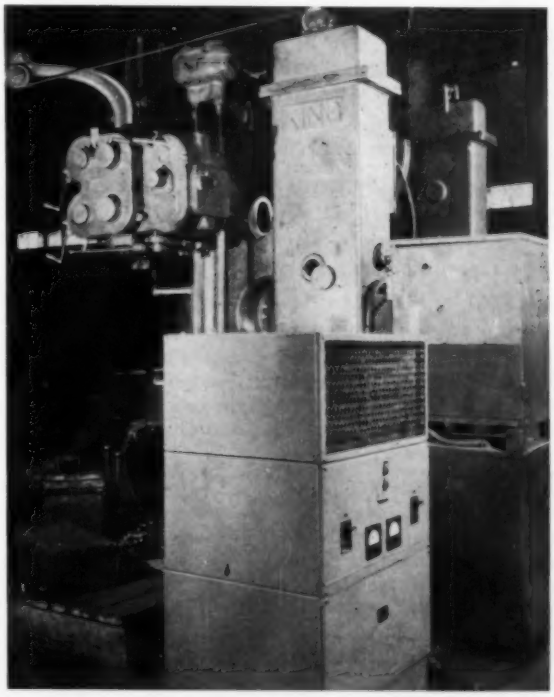

Fig. 1—This 50-kw 250-volt silicon rectifier supplies dc requirements of a large boring mill in an adjustable-speed, constant-horsepower application.

hand operated field rheostat, as against a static rectifier in a ventilated enclosure with ac linestarter, two-winding transformer and pushbutton. It can be seen that the cost of selenium types is from 66 to 86 per cent of that of corresponding m-g sets. Although a comparison for only a few sizes can be shown, the data are comparable for sizes falling between those

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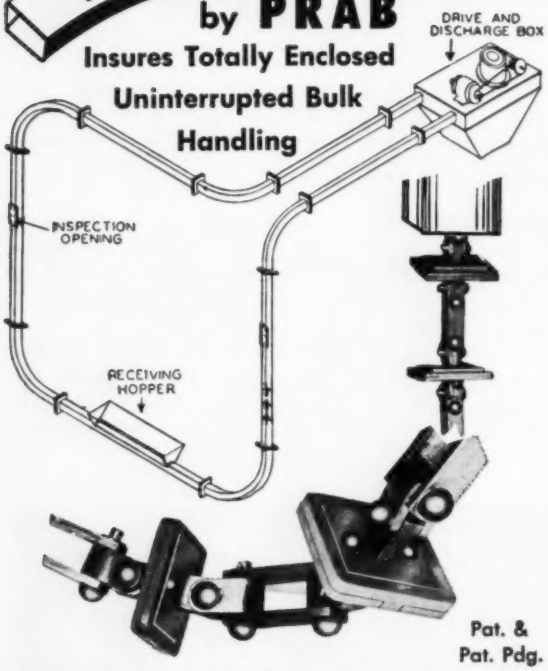

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listed. Further, rectifiers are purchased as packaged units that require no external control. Optional items such as instruments, ac and dc hand-operated breakers and indicating lights can be added to the package at a nominal cost. A new unit introduced into this lineup costs less than half the price of m-g sets in most sizes. It is a selenium rectifier designed to operate directly from a 208/120-volt, three-phase, 60-cycle network without the use of a transformer. Output is approximately 255 volts dc. Although these units are not likely to be widely applied because there is no convenient way to adjust the dc output, they do constitute a low-cost means of power conversion wherever 208-volt ac is available. As shown, costs of silicon rectifiers are currently above those of selenium, but with time, this differential seems likely to be reduced.

The packaged rectifier is the least expensive of all types of power conversion equipment to install. It requires no foundation; it does not need to be bolted down; there is no leveling to be done; and it is easy to move from place to place with a fork lift truck. Since there is continual effort in all plants to secure better use of existing equipment and increased production, users welcome a power supply that can easily be moved from place to place and even installed off the floor entirely. Since each power unit is adjusted for its name plate voltage at the time of manufacture, installation requires only the connection of ac leads to the rectifier and the two dc leads to the load. If the ac supply voltage is higher or lower than the name plate rating, taps are available for setting the dc output to the desired value. On standard units,

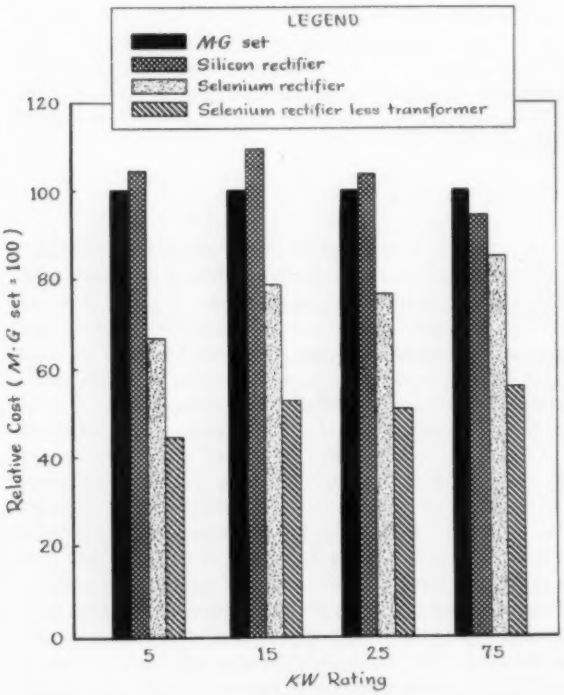

Fig. 2—Graphical comparison of initial cost of silicon rectifiers, selenium rectifiers, and m-g sets rated from 5-kw to 75-kw. Basis: m-g set first cost equals 100.

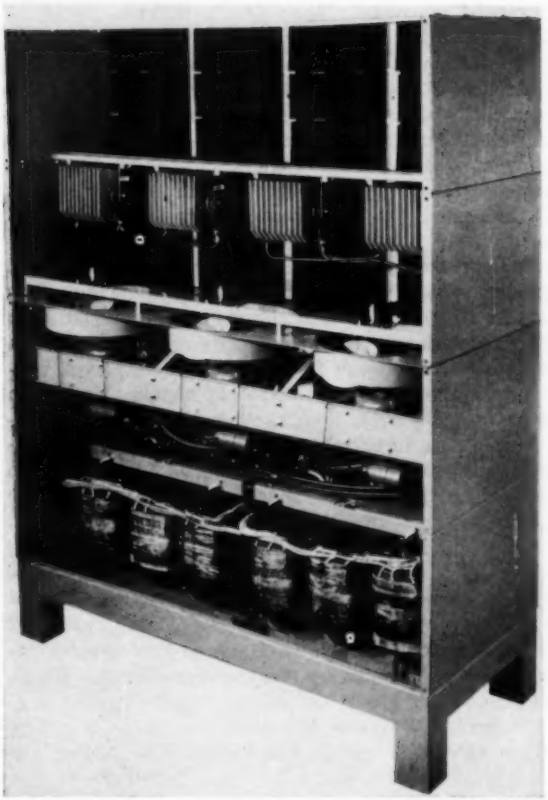

Fig. 3—Internal fan arrangement for a 100-kw rectifier. Replacing one large fan with three smaller units lowered noise volume and increased reliability.

limits of ac voltage setting are plus or minus 10 per cent of rated supply voltage.

Maintenance is, of course, an item that requires the strictest consideration. In this connection, rotating m-g sets invariably require the greatest amount of attention, while static rectifiers require the least. A rectifier installed in a reasonably clean atmosphere will operate year in and year out without any maintenance. When the atmosphere contains dust and dirt, it is well to clean the unit periodically with an air hose. Although filters can be applied to keep out much dirt these often become clogged to the point that air flow is restricted.

In today's plant floor space is at a premium and any significant saving is of great value. Comparing a typical 50-kw rectifier unit with an equivalent m-g set, the rectifier occupies a space measuring 31 by 25 inches or less than 5½ square feet; the m-g set takes up 13½ square feet, or almost three times as much space. A similar comparison can be made for the net weight of each. This is important on rectifiers because very often they are best mounted on a shelf or a mezzanine floor, out of the way. Again comparing a 50-kw rectifier with an equivalent m-g set, the net weights are 2700 pounds for the m-g set, and 1600 pounds for the rectifier. In this case the rectifier is less than 60 per cent of the weight of a conventional m-g set.

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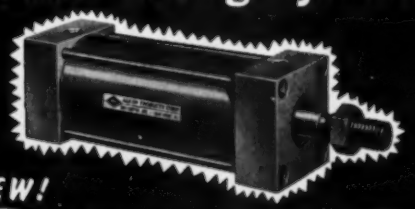

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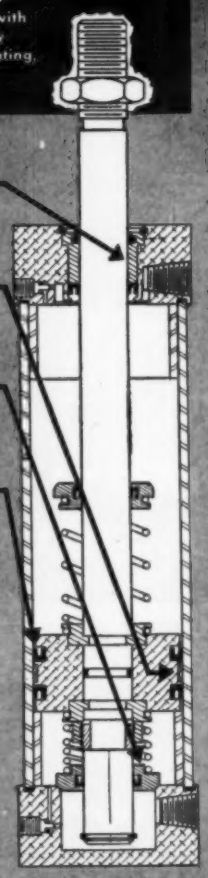

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increased attention. Noise levels in most factories are high and any measure that can reduce them is welcome. In *Fig.* 3 is seen the internal fan arrangement for a 100-kw unit. By including three small fans rather than one large one, improved reliability as well as quietness of operation is gained. The fans are mounted inside with the blades away from any screened openings, and air is brought in at the front of the unit where it is reasonably free from dirt and dust.

Increasingly, attention is being directed toward efficiency, particularly since silicon and germanium rectifers have come into the industrial picture. The silicon unit installed on the boring mill, *Fig.* 1, has a full load efficiency of 90 per cent. At half load, efficiency is about 92 per cent, and it remains high down to about one-quarter load. Light load efficiency of rectifiers is most important since, in a normal day, a power supply operates a good portion of the time at no load or on light loads. Rectifier no-load losses are normally less than half those of rotating equipment, for both silicon and selenium type power supplies.

From a paper entitled, "Evaluating Packaged Direct Current Power Sources for Machine Tools", presented at the Twenty-First Annual Machine Tool Electrification Forum sponsored by Westinghouse Electric Corp., Buffalo, April, 1957.

INFLUENCE OF AUTOMATION

By H. W. PRENTIS, JR.
Armstrong Cork Company
Lancaster, Pa.

OF THE technical factors that will affect the future of American industry, none, in my opinion, is likely to be of greater importance than automation. The word itself has only recently come into general use. It connotes a further extension of the long-time process of increasing the mechanization of industry, often aided and abetted by the use of electronic controls. In a sense, automation is "the automatic control of automatic machines." This concept has led to dreams of push button factories which would suddenly throw hordes of workers out of employment. In my opinion, this idea is quite erroneous. In the first place, the advance in automation will be gradual. Essential as it will be to hold down labor costs to meet mounting competition, it can only take place as rapidly as men can invent the required processes and equipment, and the instrument industries can devise and turn out the necessary control mechanisms. Other items that must be taken into account are the great amount of additional power that will be required and the possible lack of the extra capital needed for the installation of the necessary new machinery and equipment. Other factors that may impede its rapid progress are the tremendous demands that it will make for skilled manpower to operate and maintain the complicated equipment as well as to produce the required control devices. The question of finding markets for the increased output of goods also enters into the picture.

However, many authorities assert that increased

automation is essential to the attainment of a rising standard of living in the next fifteen or twenty years. Mr. Ralph Cordiner, President of General Electric, estimates that the United States will require 40 per cent more goods and services by 1965 with only 14 per cent more people available for the working force in that year. If this prognostication be correct, how vitally important it is that we should augment our productive facilities in every possible fashion.

Such social opposition as may develop will be due to continued apprehension regarding so-called technological unemployment. The fear of permanent unemployment from automation, in my opinion, is groundless in view of the history of the economic growth of the United States. The worker in 1850 would have required three weeks at seventy hours a week to produce as much as a 1950 worker turned out in a single forty-hour week. The number of persons employed by private business has risen from 12 millions in that year to about 60 millions now. Productivity has doubled since 1900, yet the rate of unemployment has gone down slightly. All told, the country now offers 67 million jobs, many of which would not exist if our national economy were not so advanced.

The real problem of automation will be the temporary displacement of workers rather than permanent unemployment, just as was the case of the liverymen of fifty years ago who were superseded by motor car dealers and automotive service men. The record today shows that certain industries have actually increased their employment after undergoing automation. The use of dial telephones, for example, started about 1920, and since that year the telephone operating companies have doubled their employment. The continuous flow method in oil refineries began about the same time and employment in the oil industry has increased about 100 per cent since. The rate of labor displacement that will take place as the result of automation in the years ahead will probably be small compared with the present rate from other causes. Currently about six million people leave or enter the United States labor force every month.

For the reasons I have recited, it seems obvious that automation will not strike all of a sudden like a bursting shell. It will come on gradually and allow time for adaptation and adjustment. Its primary impact will be to create new opportunities, new occupations, new skills, higher living standards, more interesting jobs and the chances of setting up profitable businesses in fields that are non-existent at present. It is obvious, too, that automation will require more people at the management level because, after all, machines cannot think. The use of judgment and imagination, which are attributes of individual human beings, will still be required. Automation in the future will play its part in both small and big business, wherever it proves to be cheaper than present methods. Hence the far-sighted manager will give the matter his constant and unfailing attention.

From a paper entitled, "Factors Affecting the Future of American Industry" presented at the Annual Dinner of the Manufacturer's Association of Lancaster, Lancaster, Pa., Jan. 1957.

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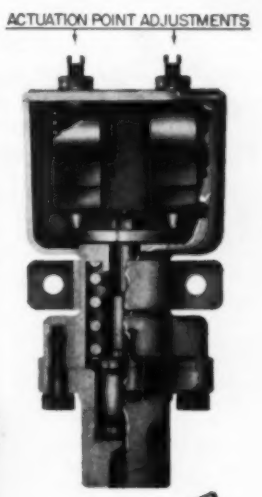

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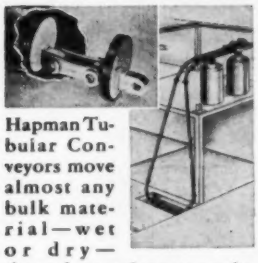

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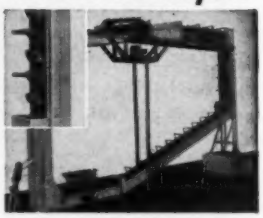

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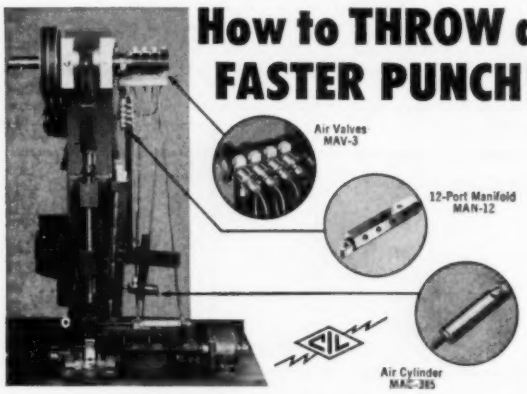

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APPLYING NUMERICAL CONTROL

By CLAUDE D. COFFIN
Senior Electrical Engineer
Warner & Swasey Co.

FOR QUITE SOME TIME now a large number of machinery manufacturers have been taking a general view of numerical controls with one basic question in their minds. Why should we put numerical controls on machinery? Many reasons have been cited and many examples have appeared, all showing marvelous gains for the users of numerical controls. However, such widely different techniques have been used on such a wide variety of machines that only one common fact seems to remain—that is, the conclusion that numerical controls have a place and should be used.

Most numerically controlled machines are completely automatic in their operation. Many of the gains credited to numerical control arise from automatic operation only. Automatic operation is a gain anytime it is obtained, and it certainly can be obtained by means other than numerical control. Many of the numerically controlled machines which have been publicized to such great extent recently can really attribute most of their gains to the fact that decisions and operations by the operator have been eliminated and an automatic cycle has been accomplished. In some cases the same automatic operation with the same time cycle could have been obtained with equal efficiency by conventional means.

Another fallacy into which we may have a tendency to fall is that by some miraculous phenomenon, a metal cutting machine with numerical control can cut metal faster than a machine under more conventional control. This definitely is not the case. The limit of how fast a cutter can move through metal is still determined by cutter life and horsepower supplied. Whether a machine has numerical control or more conventional control, the basic facts of cutting metal have not been changed.

Intimation that there are no gains from numerical control is not intended. When an extremely complex shape is to be machined, such as in an aircraft skin or spar, we have an entirely different situation. Machines with conventional controls are totally incapable of machining these shapes. Even using contour following or tracer control we find a very difficult situation. The shapes are so complex that no single template can provide all the necessary information to control the machine. This leads to a condition of multiple templates and all of the problems involved in maintaining correct relationship between templates. There is quite an accumulation of inaccuracies due to manufacturing tolerances on the templates themselves, as well as tolerances in the mounting of the templates with respect to each other. While this situation is not an impossible one, it is certainly fair to say that it is an extremely difficult one. Certainly many hours are required to set up such a machine before the first part can be made. Here is a place for numerical controls. Even though the numerical controls become very complex and expensive the gains to be realized by their use can more than justify their expense. Other jobs which fall in the same category include multi-dimensional cams and also turbine blades.

If we consider these numerically controlled mach-

ines, what does the user actually gain for the dollars he has invested in the control? He can make the first piece of a lot an acceptable piece. In other words, he does not run the chance of scrapping several pieces while setting up the machine. The other big gain is that he can change the setup quickly. The machine is not kept idle for a long period of time during setup.

With a proper record there is very good likelihood that the machine will perform its functions accurately simply because of the fact that numbers in themselves do not have any error; they are specific. This is in distinct contrast to templates, for no template can be made or mounted without some tolerance. The numerical machine can be in operation quicker because it takes very little time to insert a numerical record into the control cabinet of a machine. Many hours could very easily be spent in putting templates on a tracer machine, making trial cuts or trial motions to check alignment, and adjusting one template with respect to another. It must be remembered that the cutter or cutters and the workpiece must be mounted on the machine in the manner planned for when the record was prepared. The time involved in mounting the workpiece and cutters is essentially constant regardless of whether the machine is numerically controlled or controlled by other means.

By this brief example we can see the real gains obtained with numerical control or recorded information control; there is no tolerance in commands given to the machine, and essentially zero time is required at the machine to insert control commands. The first item is one which carries a different dollar value on different types of machinery. Therefore, we may say that this factor has high dollar value only in the case of extremely complex operations. The second item, zero control setup time, is an entirely different story. The fact that a machine can be made to produce parts during a greater percentage of the time that machine is on the shop floor certainly carries considerable dollar value for every machine. The fact that setup time can be reduced—and setup time of the controls can be reduced essentially to zero—implies many possible savings. For example: The machine can make more parts during the course of its useful life; parts can be made in smaller lots; the machine user can operate with less inventory of parts on hand. These facts in turn lead to a whole realm of imaginative thinking resulting in still more economic savings for the user of such a machine.

Selecting Type of Control

Numerical control of a machine requires some device mounted on the machine to give electrical information regarding the position of the member to be controlled. This device is known as the feedback element, or more properly, as the transducer. The transducer may take many different forms. It may be an analog or digital transducer. The analog transducer gives an electrical signal where some property

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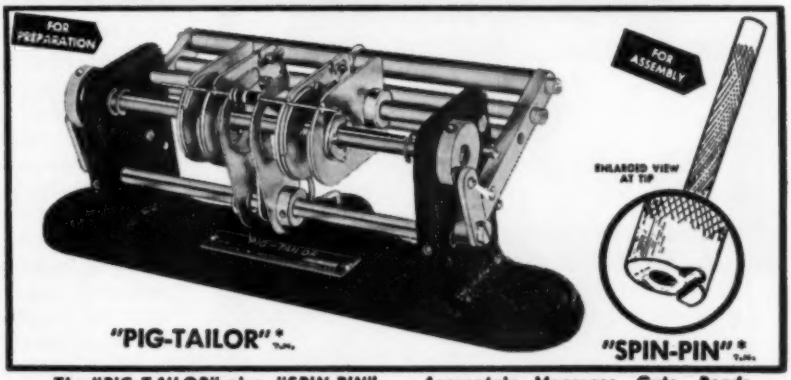

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of the electrical signal varies with the position of the displaced member. The digital transducer gives an *OFF-ON* type of signal which indicates a number representing the position or movement of the displaced member. The analog transducers are represented by such things as selsyns, resolvers, potentiometers and devices of that general nature. The digital transducers are such items as commutators, pulse generators and encoders. The selection of the feedback element or transducer is something which should be given very careful consideration by the machine manufacturer. It really is a measuring system or a gage and should be treated as such. The finest electronic control system can give operation no better than the source of information which is supplied to the control system. For this reason an attempt will be made to bring out a few points which should be given careful consideration.

Analog transducers generally measure or indicate the amount of something corresponding to a position. Use of this information then requires a precision measurement of the electrical quantity involved. In general, one-tenth of one per cent is a pretty fair accuracy for measurement of an electrical quantity as well as for precision of manufacture of the transducer itself. This factor, taken as a limitation, would mean that if we must know the machine member position to one-thousandth of an inch, a single analog transducer can be used for a total travel of one inch only. This, of course, is not adequate for most machine member displacements. Hence, when using analog techniques, it is generally necessary to use more than one transducer on each motion. This means gearing between the transducers. The electrical information from the slower or coarser transducer is used until the faster rotating or finer transducer can be used. It is frequently necessary to go to three or even four analog transducers.

Another technique calls for using only the fine transducer and electrically keeping track of which rotation it is in throughout the cycle of the machine. This really amounts to instructing the machine member to rotate the transducer, and keeping track of the fact that it has followed each minute instruction to the extent that it never gets out of its proper position by a complete rotation. The instructions to the machine member drive must appear in small increments or continuously and so a large amount of data must be supplied to the machine. This is essentially an incremental system of measurement since there is never an electrical signal which gives complete information of the machine member position. This type of operation is apparently quite adequate in some instances.

Digital Transducers

Digital transducers are quite different in their characteristics. The accuracy to which digital transducers can be used is not in any sense of the word a percentage type of measurement. It does not depend on how much of any quantity is being handled. Instead, a quantity of something is turned on or off for each digit. Hence, the accuracy to which a digital transducer can be used is really determined by the

fineness with which the transducer can be manufactured. This precision, in combination with various methods of gearing to a machine member motion can result in almost any desired degree of accuracy. For example, one arrangement using the optical interferometer principle is very capable of measurements in terms of a few millionths of an inch. With a linear digital transducer the precision of measurement does not depend on the total length of travel. On a rotary digital device the limit of precision is determined by the diameter of the rotating part (the same linear distance between digits represents a finer division of a rotation when taken on the circumference of a larger circle).

The next item of consideration as we progress from the machine toward the record is the control cabinet at the machine. Unfortunately the machines which have received the bulk of the publicity to date have control cabinets which are large, complex and expensive. This is probably the main reason why machinery builders have been slow and cautious in using these techniques. The complexity of a computer varies greatly with the problem it must solve. So far, the greatest amount of work has been done on the most difficult problems. Cutting curved surfaces in two or more dimensions is a difficult problem and has led to large computer controls. Many different approaches have been taken to solve these complex problems. Some of the more recent approaches have resulted in simpler controls, showing that progress is being made. Fortunately, many machines do not involve such problems as curved cuts. In these cases, with simpler problems, the computer becomes a more reasonable piece of equipment.

The amount and complexity of the data which must be supplied to the computer or data handling equipment at the machine is the most vital fact in determining what media should be used to supply the information to the computer or machine control. The most common types of data storage media are punched card, punched tape and magnetic tape. Some machines use two types of storage media for the same machine.

Magnetic tape is generally preferred for the most complex operations. This preference stems from the fact that magnetic tape can record almost continuous variations of information. It comes very close to an analog type of storage medium. Magnetic tape can be used to store amplitude, phase, frequency, pulse width and other types of modulated electrical signals. Where continuous curves or continuously changing positions of a machine member are necessary, this type of storage medium seems ideally suited.

Punched tape, in contrast to magnetic tape, records numbers directly. There is no continuous variable recorded. Each line across the punched tape has a fixed number of hole positions which have either been punched or not punched. In general, a line of these holes across the tape will represent one decimal digit of a dimension. To specify a complete dimension requires several lines of hole positions. Another line of holes is often required for address. Address is an

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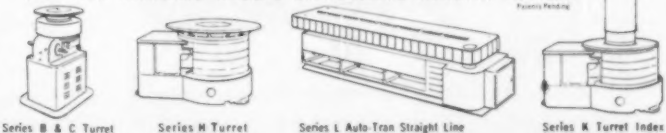

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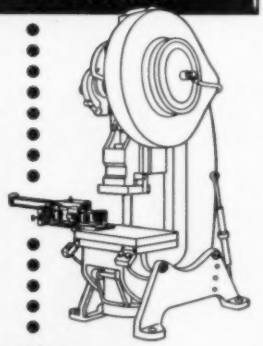

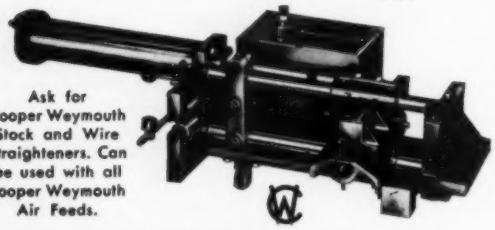

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instruction stating what interpretation should be given the group of holes. The address generally precedes a block of holes and will give an instruction such as: The following group of holes are to be interpreted as an X slide position; the following group of holes are to be interpreted as a spindle speed; or any such instructions for which the control system has been designed. When such a system is used with punched tape, it is apparent that many rows of holes across the tape are needed for a complete instruction. Since most tape readers have a finite top speed and normally read only one line of holes at a time, it immediately becomes apparent that information can be taken from a tape to a machine only at a rather low rate.

One means of avoiding this situation is the use of the incremental system. Instead of recording complete dimensions on the tape, the tape is punched with numbers indicating the difference between the last and the next dimension. This reduces the size of the numbers recorded on the tape and so they can be spaced closer together and read faster. Another scheme is to move the tape at essentially constant speed, having the holes on the tape represent the number of thousandths of motion desired during the period of transit of the tape. This allows rapid movement without necessitating extremely high tape speeds.

Punched tape is not an ideal data storage medium but in spite of its many drawbacks it is finding quite general use. The biggest reason for this wide acceptance is that it is probably the most economical type of data storage equipment. It has been well developed for use in other industries and is commercially available from several suppliers.

The other common form of data storage is punched cards. We can regard each punched card as supplying a block of information. A punched card can store a tremendous amount of information. Punched cards are in common use with nearly a thousand hole positions per card. Such large storage capacity makes it reasonable to use rather redundant storage codes to obtain other benefits, such as these: It becomes feasible to use the conventional one-out-of-ten number system with separate columns for the given digits; it is possible to have cards printed with designation of the various columns in terms of the machine operation controlled by the column; it even becomes reasonable to include on the cards miscellaneous information such as part or drawing number and card sequence numbers.

Punched cards have many advantages but they are not all gain. Cards in themselves have a way of getting mixed up in a pile. This causes considerable confusion, to say the least. Cards also become frayed around the edges and sometimes refuse to work satisfactorily in a card reader. Card punching, handling and reading equipment is considerably more expensive than similar equipment for the other forms of recorded information.

From a paper entitled, "Numerical Control for Machinery" presented at the 1957 *Design Engineering Conference of the American Society of Mechanical Engineers in New York, May* 1957.

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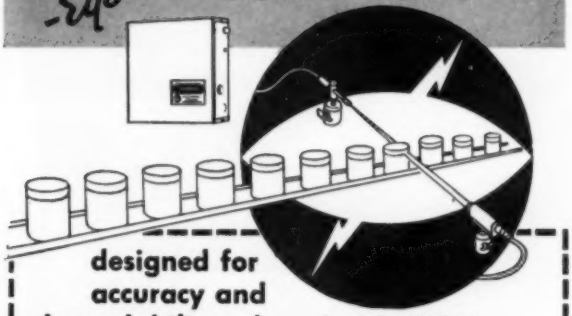

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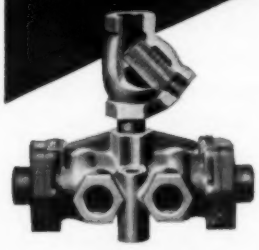

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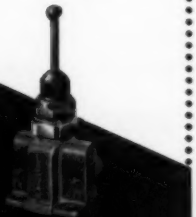

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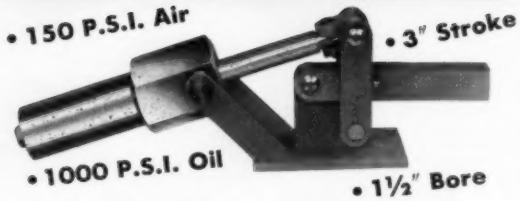

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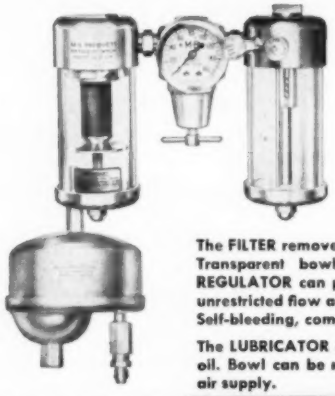

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CONVEYOR FOR HOT MATERIAL

Flexible belt conveyor has suitable heat-resistant material on both faces. Installation provides a twist in the return run so that each face contacts the hot material only every other cycle. Patent 2,784,834 by James O. Trinkle, assigned to B. F. Goodrich Co.

ELECTRICAL WEIGHING OR MEASURING APPARATUS

Magnitude of a quantity is measured by the amount of shift in the relative positions of two spaced apart coils and an armature influencing their reluctance. Patent 2,786,669 by Edward S. Safford and Willis R. Swanson, assigned to Control Cells Corp. Inc.

WORK INDEXING ARRANGEMENT

Movable work holders having projecting lugs are intermittently indexed by a cylindrical cam surface which engages the lugs. Patent 2,789,683 by Alfred R. Stahl, assigned to General Electric Co.

ARTICLE FEEDING HOPPERS

Combined agitator and feed scoop rotated in a hopper containing articles to be fed engages and aligns them with an outlet feed tube. Patent 2,790,548 by Robert P. Scherer, assigned to R. P. Scherer Corp.

METHOD AND APPARATUS FOR THE CONTINUOUS CASTING OF METAL

For the continuous casting of metal sheet, molten metal is fed to a cavity and flows up between two cylindrical rolls which rotate in the direction of metal flow. Patent 2,790,216 by Joseph L. Hunter, assigned to Hunter Engineering Co.

WORK-LOAD INDICATOR

Hydraulic valve device, for use on a machine tool having a fluid motor for feeding a tool, renders the tool inoperative when the tool reaches a predetermined dullness and the pressure drop in the motor exceeds a given amount. Patent 2,790,340 by Chester A. Cross, assigned to Machine Tool Control Corp.

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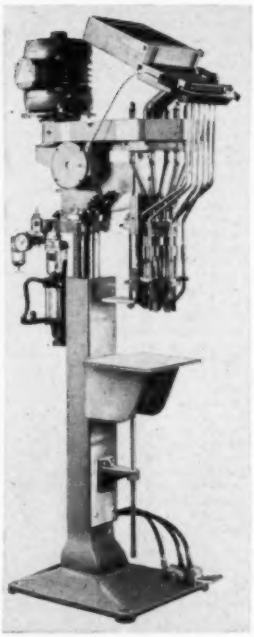

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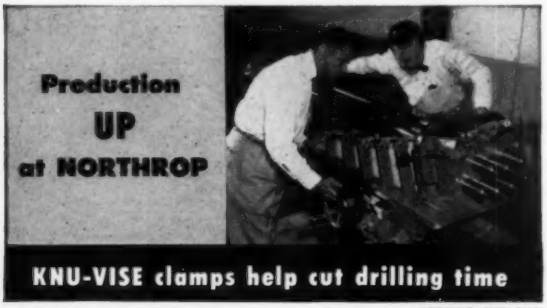

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MATERIALS AND PROCESSES IN MANUFACTURING

By E. Paul DeGarmo, professor of industrial engineering, University of California at Berkeley; 755 pages, 6 by 9¼ inches, illustrated, clothbound, published by Macmillian Co., New York; available from AUTOMATION; *$8.75 postpaid.*

This profusely illustrated book surveys the broad fields of materials, processes and manufacturing techniques as applied in modern industry. Prepared as a college text for engineering students, the information contained in this book is of interest to people in industry as well. Materials are discussed on the basis of why they are chosen for certain applications, and how they react when processed. Manufacturing processes such as heat treating, casting, forming, machining, and joining by welding, brazing and soldering are covered. Equipment to perform these operations is discussed from the point of view of its relative suitability and limitations. The concluding section of the book describes techniques relating to manufacturing such as layout, finishing methods, and planning.

AN ENCYCLOPEDIA OF THE IRON & STEEL INDUSTRY

Compiled by A. K. Osborne, technical librarian and information officer, the Brown-Firth Research Laboratories; 558 pages, 5¾ by 9¼ inches, illustrated, clothbound, published by Philosophical Library Inc., New York; available from AUTOMATION; *$25.00 postpaid.*

This English reference book contains explanatory definitions of terms for materials, tools, processes, etc. associated with the iron and steel industry. Terms are covered alphabetically in a dictionary type format. Sources of material are referenced and conversion tables are included. Names and addresses of scientific, technical and trade bodies related to the iron and steel industry are also given.

Association Publication

AUTOMATION AND OTHER TECHNOLOGICAL DEVELOPMENTS

By David A. Morse, director-general, International Labor Office, paperbound, 105 pages, 6¼ by 9½ inches; available from International Labor Organization, 917 Fifteenth St., N. W., Washington 5, D.C.; $1.00.

This material, part 1 of the report of the director-general at the fortieth session of the ILO at Geneva, discusses on an international scale the social implications and problems of automation. Sections dealing with current progress, employment, training, displacement of workers and social security needs as related to automation cover these topics in detail.

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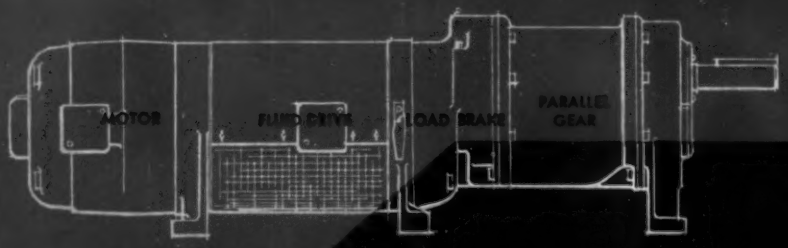

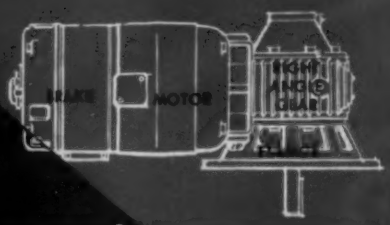

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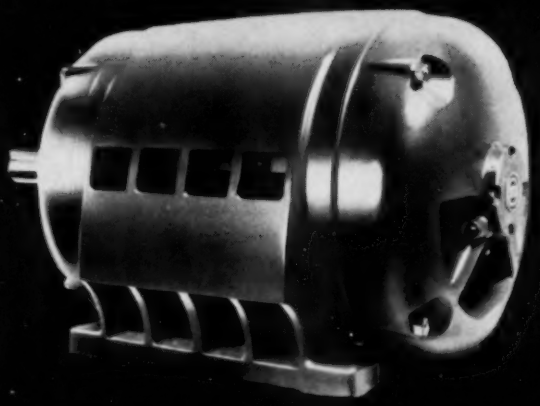

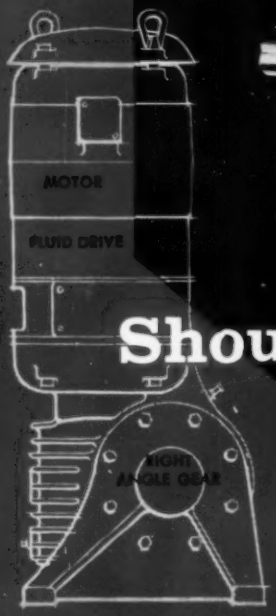

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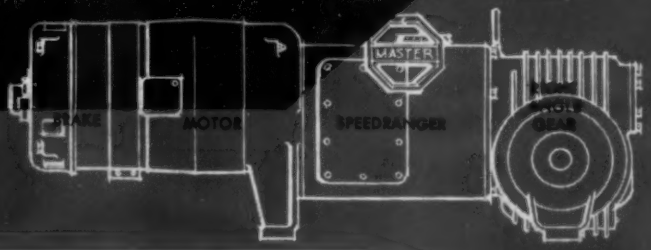

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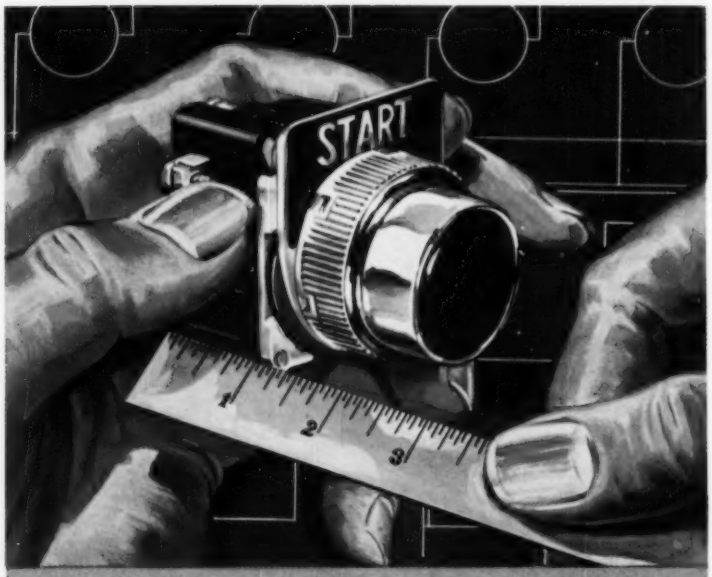
Machine designers say these new heavy duty pushbutton units have no equal and prove it by adopting them as standard equipment



These are the world's smallest heavy duty pushbuttons. They require a behind-the-panel depth of only 1 3/32". This is 40% less space than needed by the next smallest units on the market. Double-pole contact blocks are available in all combinations of normally open and normally closed contacts. Each control circuit is electrically and mechanically isolated from the other. Each circuit is clearly identified and all terminals are color coded. Rapid on-the-job circuit additions are obtained by stacking contact block on contact block.

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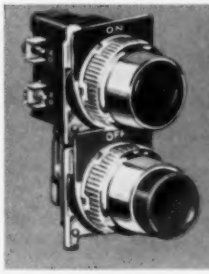
☆ *they last longer*

Design engineers are quick to recognize that these new heavy duty pushbuttons have *everything*. There is nothing on the market like them. They are amazingly compact to require the least back-of-panel depth. They are one-hole mounting and they are oil tight. They easily provide for as many as eight separate control circuits per pushbutton, eight completely isolated heavy duty contacts either normally open or normally closed. The buttons may be flush type, the extended type or with mushroom heads. They can be black, red, yellow, green or gray. See the new one-button control station, C-H Roto-Push. See the easiest-to-install maintained-contact pushbutton attachment and the means for padlocking any of the standard pushbuttons. There are both knob and key operated selector switches in this complete line. Also matching indicating lights and the new automation safety light, PresTest. Be sure you have complete information *now*. Write today on your company letterhead for a copy of the new Cutler-Hammer Pushbutton Handbook Pub. EL-178. CUTLER-HAMMER, Inc., 1466 St. Paul Ave., Milwaukee 1, Wisconsin.

These pushbuttons may be flush type, extended type or with mushroom heads . . . in a wide range of colors for quick control identification. Standard, large, and jumbo size legend plates fit every type of operator and indicating light in the entire line.



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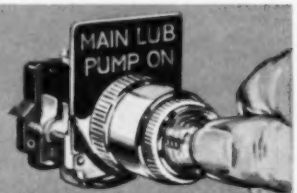

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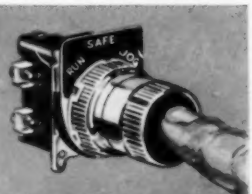

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